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Andrew Carnegie

A PICTURESQUE figure in American industry has disappeared with the death of Andrew Carnegie. Rising in the day when business was untrammeled in its methods of competition, he stood out as the most venturesome and successful of the captains of industry. As an organizer and a developer of men he had no equal in his generation. Those rushing days, however, have been largely forgotten, for the Carnegie of recent years has been a public benefactor, a patron of science. The engineer has special reason for remembering him. He relied on engineers in building the steel industry, and he paid his tribute to them and rendered his thanks tangibly in the home he gave the national engineering societies in New York City. Carnegie Institute of Technology, in Pittsburgh, he endowed that young men might be educated in engineering; the Carnegie Institution of Washington he founded for research under the broadest possible charter. Whatever may be said of his fighting methods in the days of his power, he has left us a fine example of what grit and energy can do, and in his later years laid down a model that deserves emulation by those who have been plentifully blessed with this world's goods. In the days of his power, too, he was but playing the game that was being played against him.

Efficiency, in Theory

AGAIN may come from the railway brotherhoods' injection of soviet ideas into the current economic discussion, for they recognize in their advocacy of the Plumb plan that the sound means of lowering costs is to increase efficiency, since upon an increase in efficiency they would depend for profits. The mere admission of this fact, though, is but a beginning. We need results. To secure them, leadership, preferably by the President, as set forth in another column, is necessary, and the passing down of the doctrine from union heads in Washington to every local and to every individual. The individual must understand that labor is the largest element in production cost, and therefore in selling price. The brotherhoods have made a good start in enunciating theory. Will the American Federation of Labor build a program on that theory and help get results?

Mr. Hurley and Montauk

TWO weeks ago we asked the Shipping Board to explain why it contemplated the construction of two new mammoth Atlantic liners and why, as announced in some detail by the board itself, it was playing with the old Montauk Point pier and terminal scheme. The first of the two questions remains unanswered, but the second, Mr. Hurley, the chairman of the board, now answers with a denial. In a letter to the Dock Commissioner of New York City, he states that the question of developing terminal facilities at Montauk Point has never been seriously considered, and that obviously there is nothing to be gained by going there when the piers at Hoboken can take care of the 1000-ft. ships. This sounds sensible though belated, but evidently something is wrong with the publicity department of the board which circulated the original statement.

Orderly Progress Is Safe Progress

IT IS unfortunate for orderly progress in the settlement of our industrial difficulties that the railroad brotherhoods should have made such a tremendous leap in their demands upon Congress. We were rapidly coming to the time when employee boards and committees were general in industries where bad conditions had prevailed. Profit-sharing has, of course, become even more common than managerial participation. In fact, two of the plans proposed for settlement of the railroad problem—those of the Association of Railway Security Owners and of Director General Hines—provide for profit-sharing by the employees. Moreover, so far has the thinking of business men gone that in the referendum vote of the Boston Chamber of Commerce on the railroad situation, just completed, 446 voted in favor of giving employees representation on the directorates and only 157 against the proposal. Orderly progress is the only substantial progress, and orderly progress requires a gradual development of the employees' functioning in management.

New Methods for New Tasks

PROBLEMS lead to progress. The problem presented to the constructing engineers by the City Hall section of the Philadelphia subway was so formidable that existing methods would not suffice, and a remarkably original procedure of downward building resulted. Its effectiveness is proved by the successful way in which the task was executed, and it is clear that the resources of the art of subsurface construction have been notably increased by the development of the new method. Our description of the intricate operations involved in the enterprise is limited to a setting forth of the essentials of the method, but it is to be hoped that full details of the variations made necessary by local conditions will be placed on record later on. The abnormally high cost of the City Hall subway section is in itself enough to give the work prominence, the more so as in this case cost is a fair measure of difficulty and technical importance; only too often it defines mere size. All the elements of difficulty and cost will, of course, survive in the form of a permanent financial burden on the shoulders of the Philadelphia public. This, unfortunately, is a quite unnecessary burden in so far as a change in location of the subway

would have avoided the difficulties that are responsible for the great cost. Indeed, there is almost as much opportunity for studying the City Hall subway work from this standpoint as from that of the originality of construction method.

Old and New Compound Rails of the Same Type

HOW invention—like history—may repeat itself, and how methods impracticable at one time may become more practicable under later conditions, is illustrated by the letter on compound rails on p. 336. The wear of a rail is mainly on the head, but when this has reached its limit the entire rail must be removed. This condition has led naturally to designs of rails in which the wearing element or head is independent of the supporting element. The object may be to make the head renewable, as in many of the older types of street-railway track construction, or to apply a head of specially high resistance to wear. As to the steel-capped Canadian rail of 1871, shown in the illustration, the methods available at that time for applying the head or cap were inadequate, so that the head became loose and the rail defective or even unsafe. With a development of the same idea in 1906, or 35 years later, modern machinery was devised to clinch the head much more firmly, by powerful pressure. Whether the cost and difficulties in manufacture of the compound rail would offset any advantages is another question. An unfavorable answer is indicated by the very limited use attained by the modern cap-head rail.

Experience With Bolted Connections

FOR some time past, steel erectors have believed that field bolting of certain kinds of steel structure is as good as field riveting, or better. Among engineers, on the other hand, the tendency to specify field riveting and eliminate bolting has increased rather than decreased. It can hardly be said that lapse of time has brought to light a satisfactory amount of definite experience to decide between the two views.

From a study made for us by R. Fleming it appears that bolting shows up well in tests, and, in a very limited record of data, has given good account of itself in service. Besides revealing the dearth of tangible experience in the subject, the study suggests that the few available items of experience have not exerted much influence on engineers' specifications, so that field riveting is very widely specified for all types of steel structure, and the economy of bolting receives no consideration. Clearly, money is wasted when riveting is required where bolting would do. But, even more clearly, many additional data of experience are needed if conclusive evidence on the service value of bolting is to be had without unnecessary delay. We hope, therefore, that engineers possessed of practical data on the subject will contribute it as a supplement to Mr. Fleming's study.

That precedent plays so large a part and actual experience-data so small a part in this particular item of engineering practice is worth a moment's thought. Experience does not always accumulate, in spite of the common belief that it does. In respect to field bolting versus riveting, for example, five or six decades have yielded a record of definite experience that is all but negligible and is actually ignored; we still govern ourselves largely by copying prevailing practice—and what we like to consider "best" practice; namely, the costliest practice.

The fact is that in this subject, as in some others, what may properly be called "experience" develops through the piecing together of a multitude of small scattered items of observation, very few of which can come under one man's eye. The separate bits of information are worthless if not assembled, yet they scatter so widely that they fail to come together unless deliberate effort is made to search them out and build them into a group. Mr. Fleming has begun this grouping with respect to the subject of bolts and rivets. The ultimate success of such work, however, is apt to depend on the willing coöperation of engineers working under many different conditions. Contribution of data from each man's experience to the common fund is one of the fundamental processes of engineering advance.

However, the current views unfavorable to bolting are based on something more than a passive ignoring of good service rendered by bolted structures. Uncertainty with regard to permanent tightness is a large factor. There are two points of question in regard to bolted joints in steelwork: The deficiency in bearing, as compared with rivets (which presumably expand so as to fill the rivet-holes), and the possible loosening of the nut. As to the former, static tests give a reassuring answer. On the nut question, however, tests are not satisfying, for everyone has daily opportunity to observe the uncertainty of tightness of a bolt. The prime need for information on the actual service of bolts in steel structures relates to this matter of loosening. And here again unfavorable evidence is bound to receive more weight than favorable; a hundred bolted buildings—or bridges—that stand for years with joints unimpaired in tightness will not hold up the one that loosens and fails.

Production and Patience

LAST week the President went before Congress to discuss the high cost of living. The specific methods he suggests may well be left to other papers for discussion, but two features of his address ring so true and have so great a bearing on the social problems of the minute that they must have emphasis. He insisted, first, on the need for increasing production, and, second, made it plain that he had no tolerance for those who by strikes or threats of strikes propose to take advantage of a serious situation and of the public.

In saying that we must increase production the President was not enunciating anything new. Throughout the war the slogan was, "Increase production and decrease consumption," while since the armistice the assurance has been constant that the high wages of the war period could and would be maintained only if the worker would increase his efficiency, would increase production. The President couples with his counsel, however, a new reason. Without us Europe is lost, and we shall go down in the wreckage. We saved her in a military sense; we must save her economically.

In actual fact, the sacrifices and sufferings of the war are not over; only the armed conflict is at an end. Not until normal conditions are restored everywhere shall we have the peace of 1913, and until we have such a peace nations and individuals must suffer for the destruction that has been wrought. This doctrine must be preached and accepted for years to come.

The chief preacher, for the country has selected him as leader, should be the President. Will he be equal to the occasion? Even his staunchest supporters must at times have a wish that the man who died recently at Oyster Bay could be handling the situation. Whatever Roosevelt's faults, he had the ability to popularize great issues. One can easily imagine the propaganda he would now set on foot to continue the sacrifices, the patience of the war, until the redemption was complete.

The other feature of the President's address to which reference has been made, his declaration against the use of force in this crisis, has had well-nigh universal acclamation. With his capitulation to the brotherhoods in the so-called eight-hour matter of 1916 in mind, there were fears that he would condone the action of those labor elements which have been threatening to strike. Instead, he stood up for law and order. He did not mince language. "There must be no threats. . . . The world has just destroyed the arbitrary force of a military junta. It will live under no other. All that is arbitrary and coercive is in the discard."

Then he enunciated what every sane thinker knows —that the great mass of the people will insist on orderly solution and will resist unreasonable demands. Well said were the words, "Those who seek to employ it [force] only prepare their own destruction."

Truly, these are times for sanity, for study of problems rather than hasty adoption of what a strong group desires. Only through patience, "through steadiness and self-possession and business sense," as the President said, can we arrive at a just and a workable plan.

Meanwhile, let every one with influence pound home in his own way the slogan of increased production.

Railway Operation by the Brotherhoods

SINCE the railway brotherhoods made their demands for turning over the railways to the employees there has been a great deal of discussion, with the result, in sum, that the plan is not received with enthusiasm by the country at large. The Plumb plan was proposed months ago, but the introduction of a bill embodying it, coupled with demands, virtually an alternative, of wage increases of $800,000,000, with further requests to come, dazed the country for a few days. Analysis succeeded surprise, the weakness and danger of the proposal became evident, while in the hearings before the committee of the House the brotherhoods have injured rather than strengthened their case. The impression made on the country may well be summarized in the retort of Representative Winslow to Glenn E. Plumb, the author of the plan: "The realm of business seems the only one with which you are not thoroughly familiar."

It was but natural that in a proposal so far-reaching the minutiæ should get no attention, but that discussion should be confined to the major issues. In fact, discussion so far has not been even on the advisability of public ownership as such, but rather on the wisdom of turning over the operation of the properties to the employees. In this the new radicalism lies. Public-ownership advocacy has long been with us, but it is a new thought that the Government, having bought the roads, should surrender them to small groups of citizens, retaining no other control than could be exercised by a minority of directors, themselves subject to political pressure from the dominant interest. This goes one step beyond sovietism, because the owner—the Government—would immediately give away its property and for one hundred years relinquish its control.

The plan is socialistic—or bolshevistic, if you will—but the true inwardness of the proposal can be put simply and convincingly without calling names. In brief, human experience from the dawn of history shows that no group can be trusted with uncontrolled powers that may affect other men, without certainty of abuse of those powers. Absolute monarchs, autocracies, long-standing political rings in state or city, large combinations of capital without effective control, all have shown the unfailing weakness of human beings to take advantage of their fellows. The absolute monarch had to be restrained by a constitution and by bills of rights, autocracies have had to bow to the introduction of a lower house, political rings have been chastised by the electorate, trusts have required restraining measures, managerial despotism has been met by the power of collective bargaining. The best results come from a system where strong power is restrained and where all groups at interest have sufficient strength to demand recognition of their rights. Our Federal Government is an excellent illustration of this restrained power—a system of checks and balances between the legislative, the executive and the judicial branches.

In the proposals by the brotherhoods there would be given them an unlimited power over properties valued at some $20,000,000,000. Theoretically there would be a check by the five Government and the five official directors; actually these men would be agreeable to the brotherhood control. If the brotherhoods could force the plan through, they could control the appointment of the Government directors and—if not at once, certainly in a few years—could weed out those officials and, consequently, official directors not responsive to their wishes. In such a situation the public's interest would get short shrift until public opinion could be aroused to repeal the law—if that were possible, a 100-year lease being involved—or otherwise rectify the bad bargain.

True, uncontrolled power wrecks itself and eventually is brought to book, but the destruction wrought in the meantime may impose terrific burdens. Germany's course, and the consequent world sufferings, furnish an exaggerated example of what it costs to let power go uncontrolled and what it costs to check it.

Without moralizing, as we have here done, the dangers involved in giving so much power to one group are appreciated by the country at large. On that score alone we do not believe that there is any likelihood of the acceptance of the plan.

Aside from that fundamental objection, there enter at the present time financing difficulties that appall any one with knowledge of finance, while there are always with us the sound objections to Government ownership.

This much, though, the brotherhoods' agitation has served to do—to throw into relief the importance of the railroad problem and to focus on it the attention of the country at large, of those who heretofore have taken no interest therein. The solution eventually proposed will need both a wide understanding and a wide sympathy.

New Construction Methods in Subway Work Under Philadelphia City Hall

Difficult and Costly Work Completed—Subway Built From Roof Downward by Continuous Underpinning—Method Determined by Poor Character of Foundation of Building

WITH the virtual completion of the City Hall section of the new Broad St. subway in Philadelphia, an enterprise unique in respect to difficulty and cost has been carried through successfully. It involved what is probably the largest single underpinning task ever carried out. Furthermore, this piece of subway is undoubtedly the most costly rapid-transit structure in existence, as the expenditure for construction exceeds $20,000,000 per mile. The problems presented in the work were so serious that it

FIG. 1. TYPICAL PIECE OF OLD CITY HALL FOUNDATION

was necessary to devise new methods for dealing with them; their success as well as their ingenious detail makes them most noteworthy.

A complete change in plan and construction method is involved in the history of the work. The first data on the underground conditions at the site were incomplete, and an imperfect conception of the undertaking resulted. When the true state of affairs was understood, after work had been in progress some months, the builders developed a new construction method, involving a fundamental change in the structural design of the subway. The success of the plans made for the work is now complete.

What this work includes may be described as the undermining of the Philadelphia City Hall on an area of more than an acre, and the construction of a four-track subway with station in this area and under the two branches of the Market St. subway south and north of the City Hall, the total area being about 700 x 100 ft. The City Hall as well as the old subways had to be supported without damage from settlement at all stages of the construction work and also had to be carried finally on the new structure. Settlement was, in fact, kept down to a negligible amount. The subway undercrossings, while requiring great care, were not out of the range of normal work; the undermining and construction work under the City Hall, however, was an operation of extreme difficulty. That the cost of the work is beyond all precedent is due to this part of it, and is chargeable entirely to the original location of the Broad St. subway.

When the city's new rapid-transit system, now under construction, was planned, prior to 1915, a four-track subway was laid out along Broad St., which is the city's central north-south artery. The City Hall interrupts Broad St., but, instead of providing for deflecting the subway around the City Hall, the plan carried it directly through under the building, with only enough divergence from a straight line to avoid the 550-ft. tower in the north front of the building, which is the city's distinguishing landmark. As there is an existing east-west subway in Market St., which loops around the building, the new subway also had to cross under both branches. To build the subway on this location necessarily involved supporting the City Hall temporarily, while taking out a core under the building 45 to 50 ft. below street level, 100 ft. wide and 500 ft. long, and later transferring the load to the roof of the new subway. This operation was rendered unusually delicate by the fact that the building is of brick and stone masonry construction without any steel framework, and is thus very heavy and greatly liable to damage by cracking or even partial collapse in case of serious disturbance of the old footings.

Early in 1916 W. S. Twining, director of the city's Department of City Transit, proposed a change of location of the subway, bypassing the City Hall, except for the extreme southwest corner. The people at a special election, however, rejected this proposal, and nothing was left but to build the subway as originally laid out. At this time the construction contract was already in force.

Because of the special difficulties concentrated in the work under the City Hall and the two undercrossings of the Market St. subway, the 700-ft. section which embraces these operations was made a single construction section, and in August, 1915, a contract for building it was let to the lowest bidder, the Keystone State Construction Co., which had associated with itself for this work the Underpinning and Foundation Co., of New York. At that time the plans for the work provided for a subway roof of steel transverse girders carried by steel longitudinal girders between the subway tracks, these longitudinals in turn resting on cylindrical piers sunk as open wells.

Work began with excavation at the northwest corner of the City Hall. When this exploration work showed that the footings of the building were so poor that if exposed they would probably crumble, it was decided that execution of the work according to the plans was impracticable, and that a new structural design and method of underpinning would have to be worked out. The new working scheme would have to provide for complete replacement of the rubble walls by substantial brick or concrete masonry, but a change of roof-construction method was also

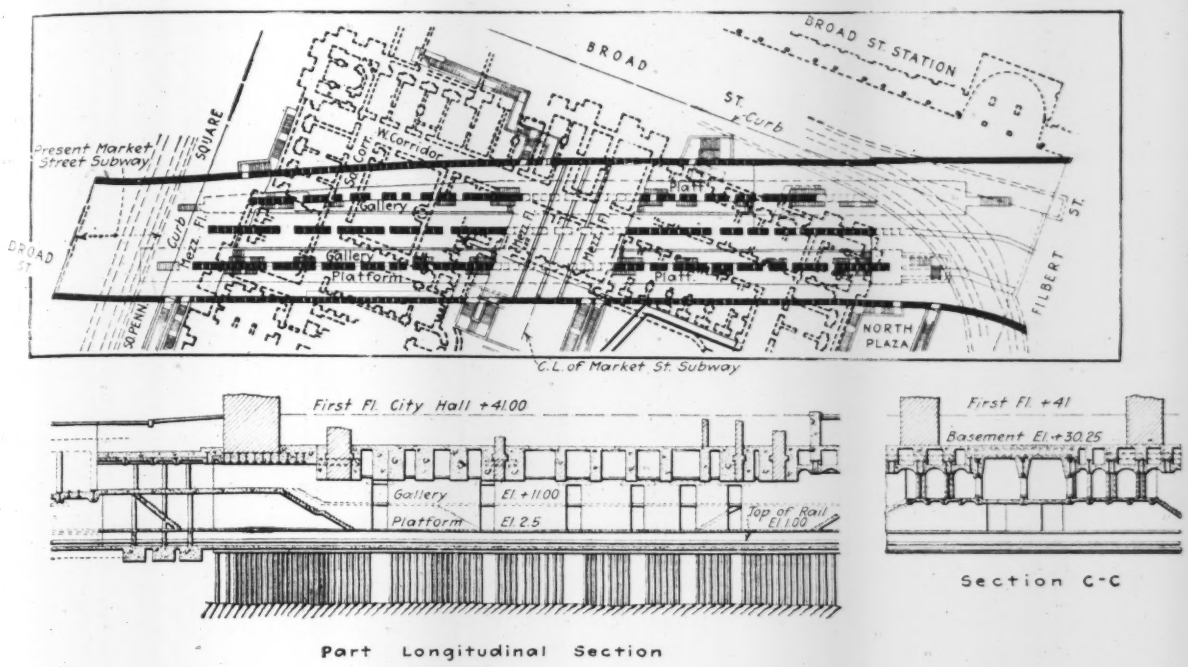
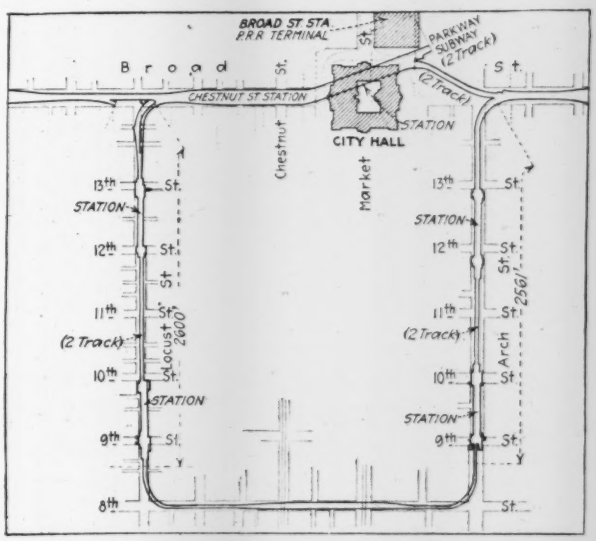


FIG. 2. BROAD STREET SUBWAY LAID OUT SO AS TO PASS DIRECTLY UNDER CITY HALL, AVOIDING THE 550-FOOT TOWER (IN CENTER OF NORTH FRONT)

necessary. Without it, since the preliminary foundation wall work would produce an initial disturbance of the building, and successive subsequent disturbances would be brought about by the insertion of steel transverse and longitudinal girders, destructive settlements were likely to occur even if the construction were so carried on as to eliminate all temporary or falsework support of the building and thereby avoid unsafe conditions.

The work thenceforward had to be developed as an underpinning enterprise, and the contractors had to formulate their construction plans accordingly. A method for rebuilding the foundation walls and a modified roof design were worked out which avoided the necessity for inserting steel girders under the foundation walls except in small parts of the area. The construction method and the changed roof design were necessarily interdependent. The Department of City Transit approved both, in the early part of 1916, and since that time work has progressed steadily and without accident, to its present completion. It was directed for the city by Frank R. Fisher, engineer of subway construction, and Dion Martinez, principal assistant engineer. The execution of the method, however, was carried out by the men who devised it, S. M. Swaab, of the Keystone State Construction Co., chief engineer, and William P. Parker, of the Underpinning and Foundation Co., construction engineer.

Stable support of the building on solid masonry and undisturbed earth foundation at all stages characterizes the method of working. Reconstruction of the old rubble footing walls was accompanied by the construction of reinforced-concrete girders or the placing of steel girders alongside of and integral with the foundation walls as a means for supporting their load



across the span between the future intertrack subway walls. Thus the entire subway roof, composed very largely of a close assemblage of girders, was constructed on the ground surface, through or adjoining the footing walls of the City Hall, forming for the time being the lowest course of the building.

It will be seen from the more detailed description that up to this stage the work was done without transferring the load of the building to shoring or falsework supports at any time. Some small amounts of shoring were used in the unit footing-wall pits in the first stage of these operations, but the stability or security of no part of the building at any time depended on this shoring, whose purpose was only to guard against any local disorganization of the masonry which would have been the starting point of cracking.

With the roof structure completed in this way, supporting piers were constructed under the ends of all

the girders by sinking sheeted pits to subgrade level, driving steel-pipe piles to bedrock in the bottom of these pits, and filling the pits with concrete to form piers. At the top these piers were finished against the girders usually by keying up with brick work, but in some instances by grouting; the building load, however, still passed from its bearing on its footings and the girders directly to the earth support, and the piers did not take load until a later stage of the work.

As may be seen from the plan in Fig. 3, the piers in question are set close side by side, and thus form continuous walls, which are the inclosing and intertrack walls of the subway, taking the place of the separate piers of the original design. By dovetailing adjoining piers together, the walls were made structurally integral, though no load transfer from one pier to the adjacent ones was counted upon in any instance. Thus, when the piers were completed the whole subway structure had been built, except for the details of floor and interior finish; only excavation of the core was needed to bring it into active service as a support of the City Hall.

Foundation Wall and Girder Construction—The key to success in the entire method lay in arranging the work so that temporary support was only an incidental factor, and so that both settlement and the elastic deformation of the elements successively brought into action were minimized to the point of being negligible. Complete stability existed at every moment; transfers of load were made in very short sections, where the wall load could be transferred without appreciable elastic distortion; and the natural ground support remained in service until the last stage. The girders being unusually deep (11 ft. in the case of the concrete girders), the deflection at the last stage also was extremely minute.

The preceding describes only the general or typical method, from which there were a number of important variations. In its details this typical method is

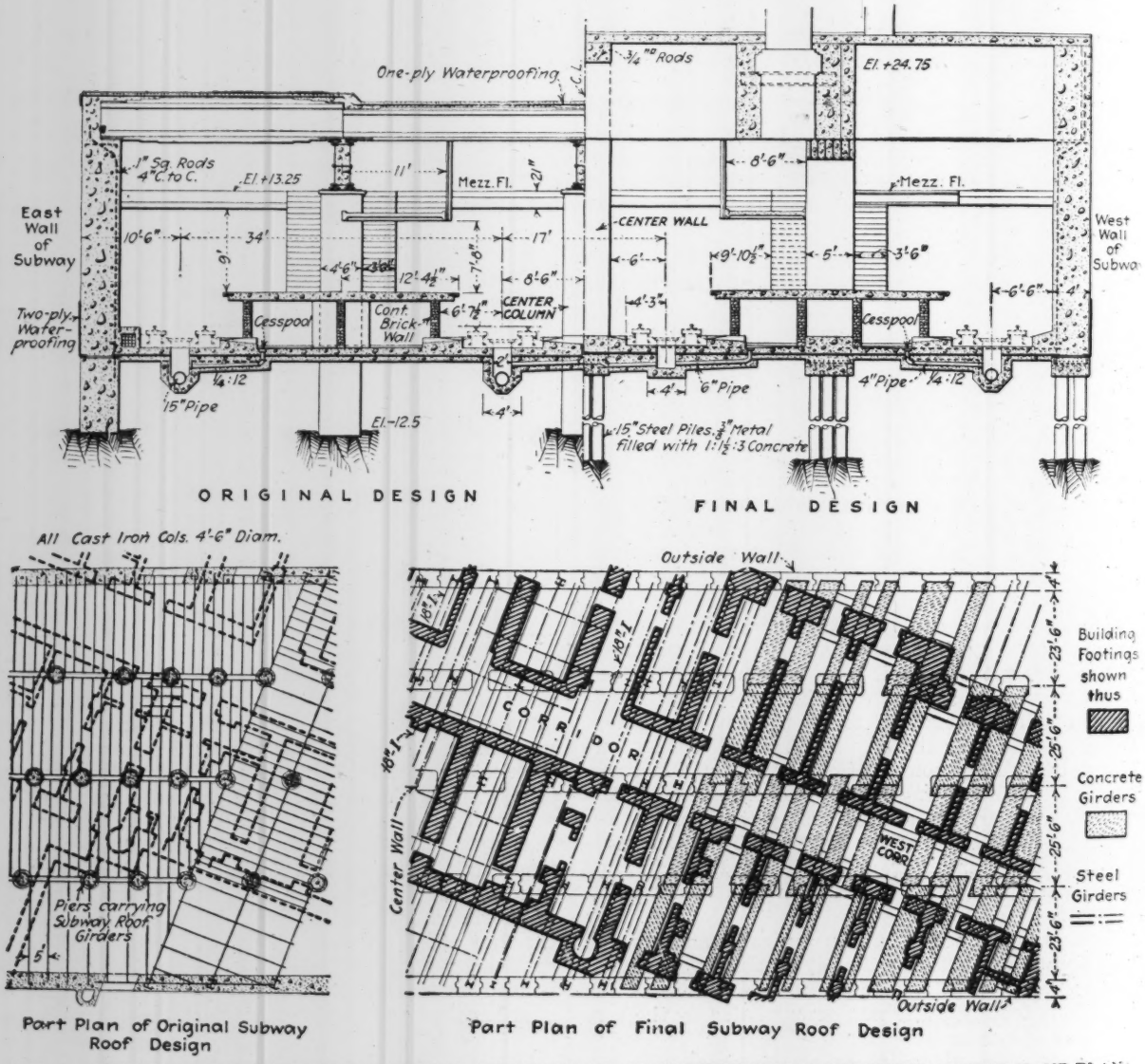


FIG. 3. CITY HALL SUBWAY CROSS-SECTIONS, AND PART PLAN; IN THE WORK AS EXECUTED (RIGHT-HAND PLAN) THE STRUCTURE WAS COMPLETED BEFORE EXCAVATION OF THE EARTH CORE

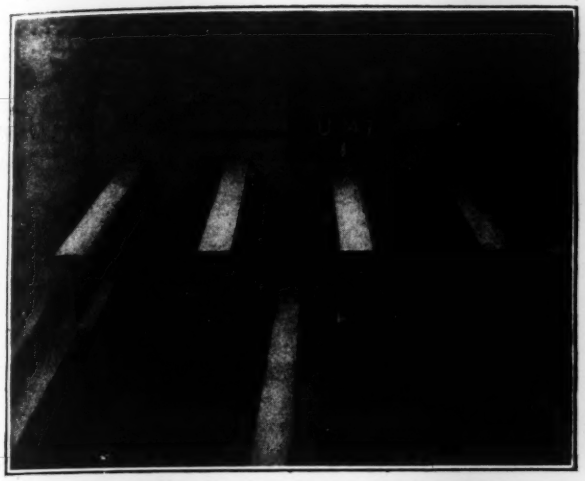


Fig. 4—Rebuilt section of City Hall footings; needle beams for ultimate support of wall

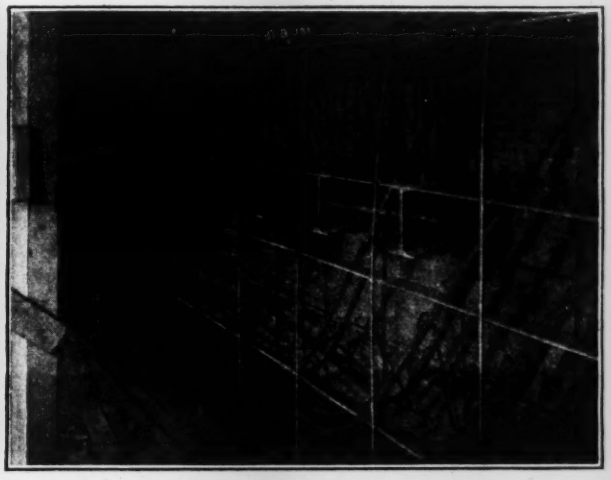


Fig. 5—One of a pair of wall girders to span one track of subway ready for concreting

Fig. 6—Steel pile foundation for subway wall pier (pit specially arranged to illustrate the method)

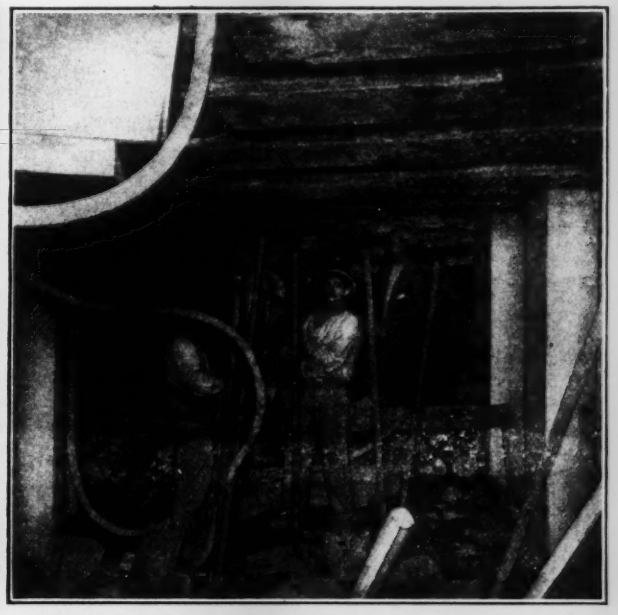


Fig. 7—Grillage and concrete under subway roof girders removed with first lift of core excavation

Fig. 8—Excavation finally exposed the roof girders and the multi-pier subway walls

Fig. 9—Waterproofed under-floor prepares subway for concrete roadbed structure

FIGS. 4 TO 9. STAGES IN SUBWAY CONSTRUCTION UNDER PHILADELPHIA CITY HALL

represented in the drawing Fig. 10. Pits were dug on either side of the wall at the point of attack, about 6 ft. long in the direction of the wall and 4 ft. wide transversely. Simultaneously, narrow slots were cut in the solid masonry above the footing wall and two pairs of 15-in. I-beams were inserted as needles, as indicated in the detail sketch A in Fig. 10. When the pits had reached the base level, 19 in. below the level of the subway roof, their floor was planked with a mattress of 4 x 8 plank and jacking drums were bedded on this, bearing against the ends of the needles. Four such posts per pit, each containing a

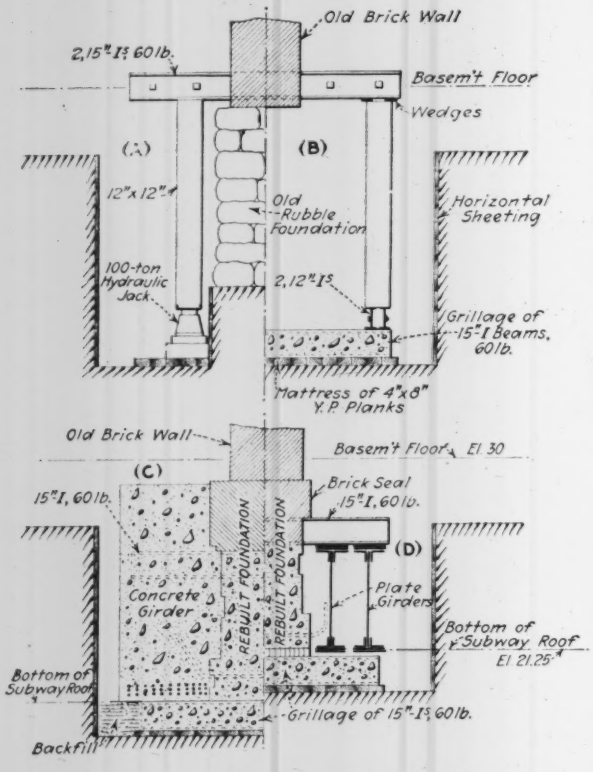


FIG. 10. DIFFERENT STAGES IN REBUILDING THE FOOTING WALLS

100-ton hydraulic jack, were used for picking up one-half the computed load on this wall section.

The old footing wall core between the pits was now removed, the plank mattress extended to make the closure, and a grillage of 15-in. I-beams laid on top of the plank mattress. The load was then transferred from the jack-posts to four other posts bearing on the grillage beams and wedged against the needle beams. Then the jack-posts could be slacked off and removed without any disturbance of the stress distribution in the wall. The 15-in. I-beam grillage was then concreted.

On the base so prepared the new foundation wall was constructed. In most instances this was built of concrete, but at some locations of brick. In either case, after the foundation wall was set up hard, the closure between old and new work was made usually with brick, the closing joint being carefully filled with mortar, shims being embedded in the mortar where necessary. Grouting was considered a less dependable method and was only used when conclusive proof of its effectiveness could be obtained. No definite transfer of load was attempted at this stage, but by the close masonry contact the new wall was enabled to take the load without appreciable deformation of any part of the structure, upon knocking out the posts under the needles. Thus the pit was brought into a condition intermediate between that of sketches B and C in Fig. 10. With the construction of the foundation wall, stirrups and projecting I-beams were concreted in, in those cases where reinforced-concrete clamping girders were to be built alongside the wall. In the case of steel girder supports, as shown by sketch D in Fig. 10, permanent needle beams were built into the new foundation wall under the temporary needles previously mentioned, to transfer the wall load to the girders.

Footing-wall reconstruction in short 6-ft. sections as described was carried on at widely different parts of the building simultaneously. When one piece of wall in a length to be carried by a single roof girder or pair of roof girders had been brought to this stage, another pit in the same length of wall was started, though this pit was not in general immediately adjacent to the first pit. In other words, work was kept scattered as much as possible, and the aim was not to disturb immediately adjacent parts either simultaneously or in immediate succession, so far as possible.

So soon as the whole length of a roof-girder section had been prepared by reconstructing the footing wall on the plank mat and grillage, the concreting or placing of the girders integral with this wall was taken in hand, as indicated in sketches C and D, Fig. 10.

As the axis of the subway makes an acute angle with the north-south axis of the City Hall, and the walls of the latter are aligned rectangularly, the roof-girder system of the subway was kept in the line of the east-west building walls, and thus is skewed at a uniform angle with the subway. The method of supporting the east-west footing walls of the building is typical, with respect to the girder arrangement, and this is illustrated in sketches C and D. In that part of the foundation where the roof girders are of concrete a pair of clamping girders is built along the foundation wall, being concreted directly against the wall and keyed to it both by offsets and by I-beam and rod-stirrup connections. Where steel girders form the roof, as occurs principally in the central section (on the axis of Market St.), these are set alongside in similar relation and bear against needle beams built into the reconstructed foundation walls, as in sketch D. These steel girders were in all cases incased in concrete and keyed to the walls in the same way as are the concrete girders. Thus the final support of the east-west walls followed immediately upon the completion of the reconstructed foundation wall, and resulted in forming the subway roof girders for the full span length (26 ft.) over one of the four cells of the subway.

For the north-south walls a generally similar method was used, these walls being in part carried on short north-south girders built between two east-west girders. This may be seen more fully and in a number of variations in the right-hand portion of the roof plan in Fig. 3. So soon as the short north-south pair of girders was completed, it enlarged the area of wall footing sufficiently to enable the space needed for constructing the main east-west girders through these walls to be cleared, and the concreting of these

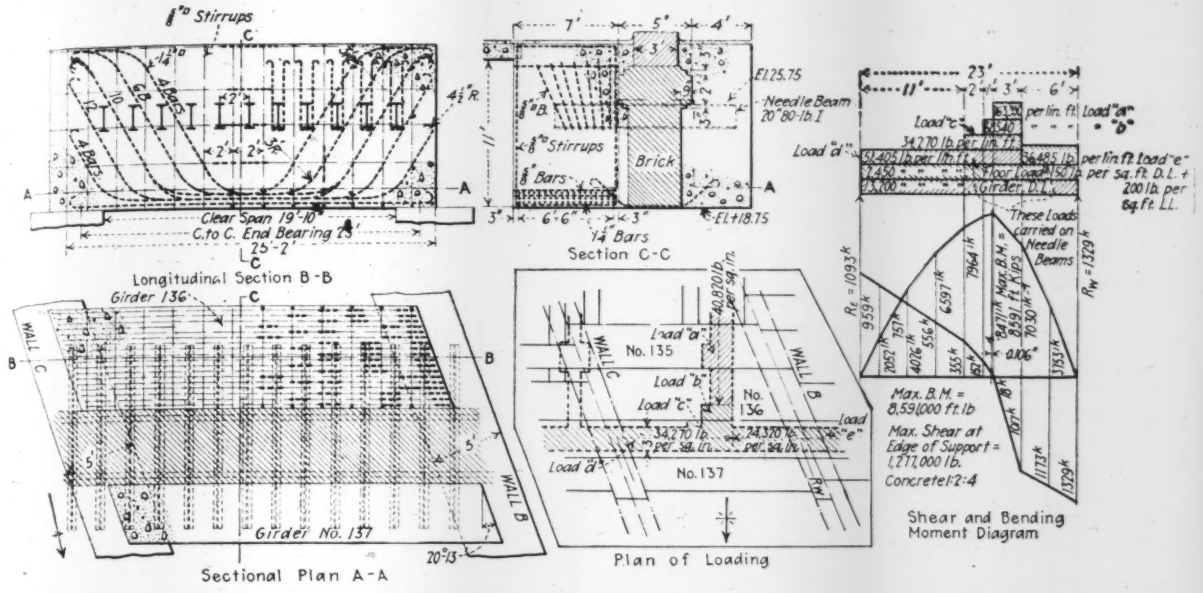


FIG. 11. HEAVY REINFORCED-CONCRETE GIRDERS CLAMP AND CARRY THE CITY HALL FOUNDATION WALLS

girders followed as the next and final step in the construction of the roof-girder system.

As already indicated, the foundation and roof-girder work was attacked at a number of points at a distance from each other. Its continuation followed the same principle and, generally speaking, the reconstruction of one piece of foundation was not followed immediately by work on adjoining sections. By wide distribution of the units of work, it was sought to avoid any local summing up of the small individual contributions to disturbance of the masonry that might be caused by slight yielding of the footings or even by the elastic distortion remaining in spite of the jacking and wedging done in transferring the load.

Very satisfactory success was achieved by these means in minimizing settlement. The average changes of level in the building due to this first set of operations, Mr. Fisher states, reached about ½ in., and the movement was in general uniform. Careful level surveys and examinations of walls for cracks were conducted from the very start. The extension of all existing cracks was carefully recorded, the original ends of the cracks having been marked. Many of the original wall cracks found in the building extended more or less, but very few new cracks developed. All indications of crack development and extension were of minor character. Perhaps most remarkable of all, a staircase that spirals around the interior of the square tower at the northwest corner of the building, formed of large granite slabs cantilevered from the tower wall, showed but two slight cracks and no opening of joints at any stage of the construction. The foundation work of this tower, however, was carried on by a modification of the typical method described, due to the nature of the footings and the concentrations to be carried, as will be noted further on.

Of course, there was no possibility of applying to this foundation and roof-girder work any systematic plan of large-scale working. Scattered operations meant small gangs and small units of material supply. Generally the footing construction was done by five-man gangs. Concrete for the foundation and girder pouring was supplied to them from ½-yd. mixers set up in some cases on the ground level and in other cases on the basement floor of the building, and was chuted to place by wooden troughs, often of intricately crooked alignment, especially for supply to the pier pits that formed the next stage of construction.

Underpinning the Subway Roof—The concrete piers which support the roof and building and which form the subway walls were constructed one by one in sheeted pits dug under the ends of the completed roof girders without any appreciable disturbance of the support of the building on the spread footing afforded by the concrete-and-steel grillage and the completed roof-girder system.

Short pits and drifts from the City Hall basement level or from the trenches in which the roof girders had been built gave access to the points where the pits were to be sunk. A four-man gang sheeted and dug out the pit, from 4 x 5 to 5 x 8 ft. in size, with shovels, and also hoisted out the dirt and dumped it on the basement floor, where wheelbarrows and ½ yd. narrow-gage dump cars took it to the shafts for hoisting to the dumping aprons. Pails and small sheet-iron barrels were the hoist buckets; a chain block supported by beams laid across the top of the pit was available for handling these buckets and subsequently the pile hammer. Sheeting was done by the louver-board method, in which successive horizontal planks, mortised at the corners to engage and brace each other in a square set, are placed at the bottom of the pit as excavation proceeds. Slots in the plank wall, formed by notches in the edges of the louver-boards, permit packing earth or cement mortar back of the sheeting to fill up voids which might start earth moving.

A new departure in the use of this method was made by carrying it below water level; previously it has been considered to be practicable only above groundwater. In this case the pits were generally sunk about 7 ft. below groundwater, but in some in-

stances a depth of 10 to 12 ft. below water level was required. The ground was a dense, gravelly soil with some clay admixture but not enough to make it tight; there was considerable inflow of water, but carrying practically no soil with it. The contractor therefore considered it possible to keep the pits dry by pumping and continue the louver-board method to the bottom. The conclusion was made good by carrying all the pit work through on this basis.

A small direct-acting steam pump lowered into a pit by a rope sling and operated by compressed air proved to be a very efficient tool for the pit drainage. Keeping the middle of the pit a foot or two below the level

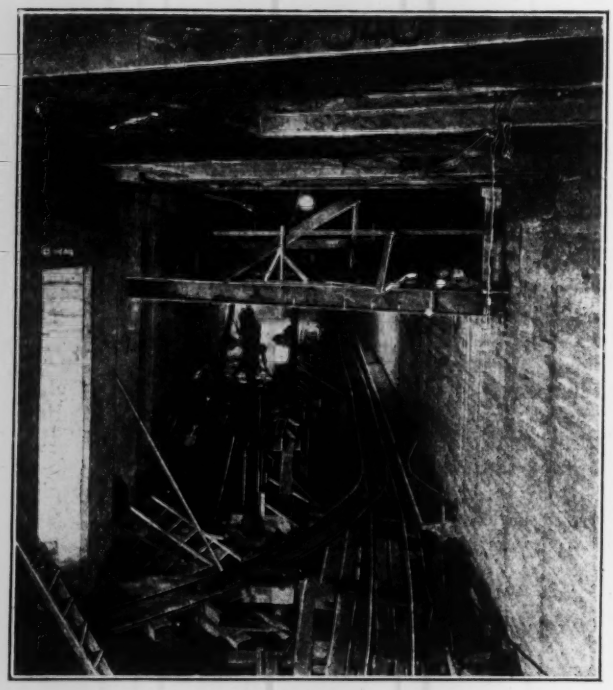


FIG. 12. BUILDING A STATION PLATFORM. NARROW-GAGE TRACK SYSTEM FOR EXCAVATION AND MATERIALS

of the outer edge made it possible to carry on excavation for the successive sheeting boards without undue movement of the ground. Clay packing back of the louver-boards was used in some cases, and in others cement-mortar packing was preferred; both gave satisfactory results.

At subgrade level the hard, gravelly clay and sand soil continued. The bearing power of this soil is high, but the loading is so great that pile foundations were necessary. Rock surface is 5 to 18 ft. below subgrade; it is overlain by several feet of disintegrated mica schist, into which the piles were driven.

The number of 15-in. steel-pipe piles in each pit varies from four (in the 4 x 5 pits) to a maximum of 15 (in the 5 x 8 pits). They were driven with a No. 5 McKiernan-Terry air-driven hammer suspended in the pit; after every 4 to 5 ft. of driving the muck inside the pipe was blown out. In this work the usual method was followed, filling 3 or 4 ft. of water into the pipe and then, with a 3-in. air pipe (supplied at 100-lb. pressure from a large receiver) lowered down on the earth in the pile, turning on the full pressure; the blast of air and water lifted out the contents of the pile, including even boulders up to clearance size. When driven to full depth the pipe was filled with concrete to an elevation slightly below that of the cap, the top of the pile was then burned off, and the cap was placed and grouted to bearing.

A loading of 90 tons was decided upon for these piles. Loading tests up to 116 tons showed no appreciable compression. Similar load tests on the soil itself, made by means of a 2-ft. square plunger and carried up to a loading of 12 tons per square foot, indicated a permanent settlement of $\frac{1}{16}$ in. per ton.

Application of waterproofing to the rear wall of the pit (in the case of the outside walls) and filling with concrete to slightly below the roof-girder level completed the pier. Close bearing contact between pier and girder was secured by keying up with brickwork or in some few instances by grouting.

All piers were dovetailed together by vertical grooves in their abutting faces. In addition, at intervals of 7 or 8 ft. in the height, horizontal keys of similar shape were provided. Transfer of load from one pier to the adjoining one was not counted upon, however, but each girder load was taken through its pier direct to the footing piles.

The same plan of scattered construction was applied to the pier work as to the roof-girder work, but the purpose in this case was not alone the avoidance of ground disturbance but also the convenient interleaving of the various items of work, the pier construction having to follow girder construction. Thus the subway walls grew piecemeal under ground. Each pit was located independently of the other, and the survey work necessarily had to be carried on with conscientious accuracy. The result is seen in the perfect alignment of the piers as they were revealed by the core excavation, shown in some of the accompanying views.

Core excavation started at the south end of the section when the roof-girder and pier construction there was complete. At this time a number of scattered piers in the north part of the section still remained to be constructed, but they were built by the time the excavation had progressed to them. Removal of the core deprived the roof-girder system and the foundations of the building of their earth support and transferred the load to the piers supporting the girders. In the aggregate the changes of level in the the City Hall due to this step in the construction work represented a general subsidence, rather smaller than $\frac{1}{4}$ in.; with this movement the total settlement of the structure due to the subway work reached a maximum of approximately $\frac{3}{4}$ in; the average subsidence was considerably below this and may be put down at $\frac{1}{2}$ in., according to Mr. Fisher.

The first lift of excavation was taken out as a shallow heading, only high enough to give working room, as the purpose here was to drive through and remove the temporary grillage footings in this operation. There was a tar-paper joint between the concrete of the grillage and the superincumbent girders and foundations, to make a separation; however, bull-point air hammers and later on, in some instances, light dynamite charges had to be used to bring the grillage down. A second lift was taken out in the full height from the first lift down to groundwater,

and this, generally speaking, was the bulk of the excavation. The third and final lift took all the material from groundwater level down to subgrade.

Pick-and-shovel work was used for taking out this earth, in view of the moderate yardage and the impossibility of providing large muck cars. Small dump cars on a narrow-gage track led back from the working face to a derrick shaft at the south end. In the work below groundwater the drainage was led to a sump near this derrick shaft.

An interesting feature of the groundwater question was that early in the life of the contract a trial was made of pumping down the groundwater. Four sump wells carried below subgrade, at distant points of the site, were pumped down for a period of several months, lowering the water level by 4 or 5 ft., but in an erratic way. The result was not considered entirely satisfactory; the success of carrying the wall-pier pits to subgrade by using the louver-board method below water level with the aid of direct pumping was soon demonstrated, and the lowering of the groundwater reduced the cost of the pit excavation only slightly.

FIG. 13. AT THE NORTHWEST CORNER OF CITY HALL BEFORE WORK STARTED

The subway is waterproofed by a two-ply layer of asphalt-treated fabric waterproofing on the outside of the side walls, extending down to the base of the walls, and a similar two-ply layer between the 6-in. sub-base of the track floor and the 12-in. top floor, notched a few inches into the side walls but not connected to the waterproofing at the back of the wall.

Work at North and South Towers.—The specially large weight concentrations at the two towers of the building under which the subway passes (that near the center of the south front, and the northwest tower) made it necessary to resort to very pronounced modifications of the typical method described in the preceding. Steel-girder support directly under the walls had to be adopted on account of the thickness of these walls and the resulting impossibility of using the ordinary concrete clamping girder method within reasonable limits of dimensions.

At the south tower the method used was substantially as follows: A trench was excavated along the southerly side of the south wall, down to the ceiling level of the subway, in this case practically the same as the bottom of the tower footing masonry. This masonry was in good condition, strikingly in contrast with the condition of the rubble foundations elsewhere. In the trench was placed a steel plate girder, a member of the subway roof system, directly against the wall and in such position as to span across one cell of the subway. Above and around this girder was cast a concrete toe or buttress to the wall, bonded into the old masonry and intended to remain as a permanent addition to the wall. The footing of this buttress on the ground increased the base area of the wall by a sufficient amount so that a narrow drift could be cut through the wall just behind the girder and buttress for the admission of a second roof girder; the bearing area removed in cutting out this drift was made up by the footing area of the buttress, and so the soil pressure conditions under the tower were not altered. When the second girder was placed in the drift cut through the wall, and properly brought to bearing against the masonry above and bedded on a mat of concrete on the soil below, another drift, for a third girder, could be cut through, and so on until the series of seven or eight girders comprising the support of this wall and the north-south walls adjoining it had been placed. With the tower fully supported on its grillage of transverse girders, drifts were excavated under their ends for longitudinal grillage girders on the line of the future subway walls, and pits for the wall piers were sunk one by one under the longitudinals and concreted.

Steel columns were erected in three intermediate pits, resting on a base of grillage beams over the group of piles in the bottom of the pit, and these columns were wedged to bearing against the girders. The function of these columns, or steel cores, was to reinforce the supporting wall at the points of heaviest concentration of the tower load.

Special Work at Northwest Tower—At the northwest tower, where steel girder construction also was used on account of the great load to be carried, the foundation walls went down lower than elsewhere, and a variation of the typical method was used.

Through the north and principal wall of the base of the tower, by means of successive drifts, the transverse girder needles designed for its permanent support were inserted and solidly bricked in, resulting in the rubble foundation being replaced by a continu- not disturbed in this initial operation. A separation joint was provided in the new work at the elevation of the bottom flange of the girders to permit the sub-

FIG. 11. NORTHWEST TOWER OF CITY HALL CARRIED ON STEEL GIRDERS

ous course or layer of brickwork extending from approximately 1 ft. above the top flange of the girder to about 6 in. below the bottom flange. This masonry, when carefully wedged and grouted against the old rubble above, transferred the entire tower load to the lower portion of the old foundation, which was not disturbed in this initial operation. A separation joint was provided in the new work at the elevation of the bottom flange of the girders to permit the subsequent dropping and removal of the masonry that extended below that level.

As three of the walls of the subway cut through the tower foundation, much pier construction work had to be carried out along and under the footing walls. Before any considerable amount of pit excavation was made beneath the foundations, the main roof girders, paralleling the north wall of the tower on either side, were placed in position and supported on the soil by brick piers and concrete slabs or mats. The projecting needle girders were then wedged to their support on the roof girders.

This method provided increased bearing area for the tower load, compensating for the loss thereof occurring during the operation of sinking the wall pits. The roof girders, with the needle girders supported thereon, were picked up by the subway walls as the work progressed. During the various stages of the construction in connection with the underpinning of the tower its bearing on the soil was maintained, and the load was not supported by the subway structure until it was subsequently transferred thereto automatically by the excavation of the core.

In general, restoration of the City Hall basement floor over the girders was carried through completely by placing a concrete slab either directly on the roof girders or on short footing walls erected over them. Furthermore, the space between girders (except where adjacent girders are in direct contact) was closed at the bottom by a thin ceiling slab set into notches formed (or in some cases cut) in the sides of the girders.

Tunneling under the south branch of the Market St. subway to construct the undercrossing had to be preceded by reconstruction of the concrete slab pavement constituting the old subway floor, in order to convert it into a bridge spanning the tracks of the new subway. As a preliminary step, drifts were carried through on the lines of the future subway wall, about 6 ft. high, directly under the floor of the old subway, and, these being timbered as they progressed, they were concreted solid (but between side forms) as soon as driven to the end. This procedure resulted

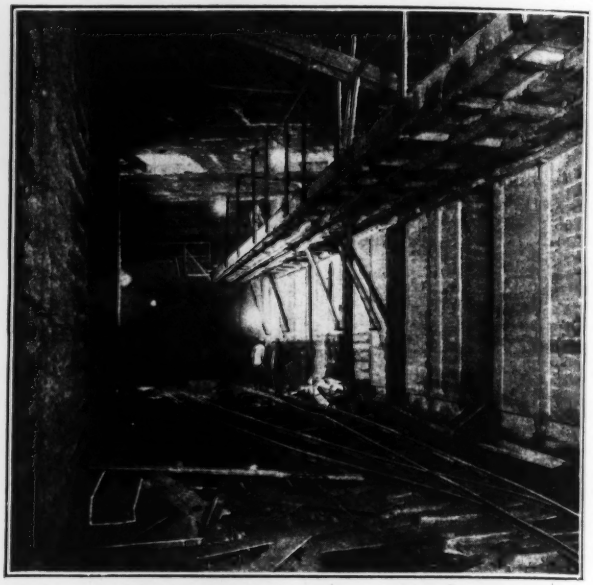


FIG. 15. PIERS SUNK SEPARATELY FORM WALLS IN TRUE ALIGNMENT

in placing a deep and rigid concrete girder under the old floor. Spanning across between these girders, the steel construction of the new floor could then be put in place, one track at a time, by night work, when traffic could be shut off or restricted to a single track. While this work was proceeding drifts were carried forward to the locations of individual piers under the party built new walls, and carried below subgrade

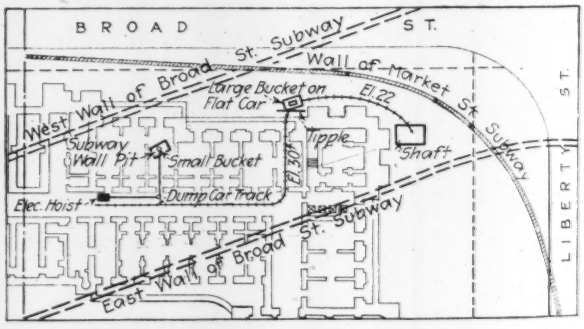


FIG. 16. HANDLING EARTH FROM PIER PIT

level. This was followed by core excavation and completion of the walls.

More complicated operations were required at the north undercrossing, partly on account of the skew of the intersection and the fact that the crossing is under the sharp right-angle curve of the north branch,

and partly because an interchange station had to be constructed here. Much more extensive reconstruction work had to be done in connection with the old structure than in the case of the south undercrossing. The work was further affected by its contiguity to the complex work at the northwest tower.

A total cost of very close to $3,000,000 is involved in the work described; the final estimates have not yet been prepared, but the supervisory officials expect the figure to approach closely this amount. As the contract was taken and its subsequent revision agreed upon before the war rise of prices, and the contractor carried on his work throughout the war, the cost to him probably exceeds the contract total computed from the unit-price figures. About one-third of the total, or something over $900,000, was expended for the underpinning work or foundation wall reconstruction.

Of the municipal and construction engineers, other than those already mentioned as being in direct charge, J. H. Fisher was superintendent for the contractors. James Shute was division engineer in charge for the city, William M. Lanard assistant engineer, and O. L. Morgenstern, inspecting engineer.

Navy Concrete Barge Side-Launched

Combination Oil and Coal Carriers Being Built on Hackensack River Have Ways Reaching Into Water

CONCRETE oil and coal barges for the United States Navy are being built in three yards, one of which, at Verplanck, N. Y., was described in *Engineering News-Record* of May 29, 1919, p. 1056. Similar boats, designed under a general Government specification by the builder, are under construction by the Ambursen Construction Co., at Little Ferry, N. J., on the Hackensack River, just above New York harbor. The Verplanck yard was designed for end-launching, but the Little Ferry barges are side-launched, as shown in the accompanying views. Two of the four barges contracted for have been built.

NAVY CONCRETE BARGE ON BUTTER BOARDS AND CRADLES PREPARATORY TO LAUNCHING

The Navy barge is 112 ft. long, 36 ft. wide and 12 ft. 3 in. deep, and is designed to carry oil in compartments and, with flashboards, a load of coal on deck. The barges are described as "500-ton coal and oil barges," but with both coal and oil aboard their capacity is nearer 750 tons. The general design of the Little Ferry barge is a 3-in. slab on frames 16 in. deep, spaced 3 ft. centers. This layout is the same on deck, sides and bottom. The bulkheads are also 3 in. in thickness and are stiffened with ribs on 3-ft. centers on both sides. Gussets at all intersections provide ample stiffness.

The yard has two sets of side-launching ways with a concreting tower midway of the two distributing to

NAVY CONCRETE OIL AND COAL BARGE SIDE-LAUNCHED

wheelbarrows on runways at the boats. For launching, the barge was held level on stringers parallel to the ways and blocked up on butter boards at the water side, as shown in one view, and on shoes or cradles at the shore side. The launching ways were stringers laid directly on the sand of the beach and descending into the water with no drop. Four of the carrying stringers extended shoreward beyond the ground ways and were blocked against the latter. Before the launching, the two middle stringers were sawed off inside the blocking, leaving the weight of the barge on the two end blocks. The stringers inside these blocks were sawed simultaneously, and the barge slid freely into the water.

The designs for the barges were made by the late Howard L. Coburn, for many years chief engineer of the Ambursen Construction Co., Inc. The construction and launching was under the supervision of L. A. Robb, vice-president of the company.

Chicago Bridge Replacement Problem

In planning the construction of a bascule bridge to replace the old center-pier swing bridge over the Chicago River at Madison St., the engineers had a serious problem in the necessity for insuring the minimum interference with traffic. This is one of the city's busiest streets, and two large railway stations are located within a block of the west end of the bridge. The method decided upon is to increase the proposed 180-ft. clear span of the bascule bridge to 188 ft. between abutments, which will allow the swing bridge to operate between the two leaves of the bascule as they are being erected in the upright position. In this way, traffic will be interrupted only during the first and final stages of work on the new bridge. It is expected that the construction will be commenced this year. This plan was devised by the city's engineers and has been approved by the War Department and the Sanitary District of Chicago.

Diagram for Locating Stirrups in Concrete Beams

Curves Facilitate Spacing of Vertical Stirrups in Uniformly Loaded Beam for Two Methods of Stress Distribution

By M. J. Lorente
Civil Engineer, Lynn, Mass.

WHEN the shear diagram of a reinforced-concrete beam has an irregular outline, it is impossible to locate the stirrups except by following some such method as that explained by the writer in *Engineering News* of Mar. 20, 1913, p. 570. When a beam is uniformly loaded, the shear diagram is a triangle, and the regularity of the outline ought to make it possible to devise a method for locating stirrups in a beam without much trouble.

The writer has worked out the accompanying set of curves, which give, in one operation, the almost mathematically accurate location of all the stirrups in a uniformly loaded reinforced-concrete beam. The figures from which the curves have been plotted were obtained from the following mathematical deduction:

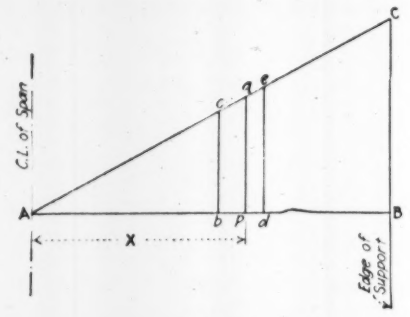


FIG. 1

In Fig. 1 let $A\ B\ C$ represent the shear diagram of one-half of a beam, and let w = load on beam per lineal foot. If the triangle $A\ b\ c$ represents the shear carried by $n - 1$ stirrups, and if the triangle $A\ d\ e$ represents the shear carried by n stirrups, then $c\ b\ d\ e$ represents the shear carried by the nth stirrup, and this stirrup should be located in a line passing through the centroid of $c\ b\ d\ e$.

To find the centroid of this trapezium would compli

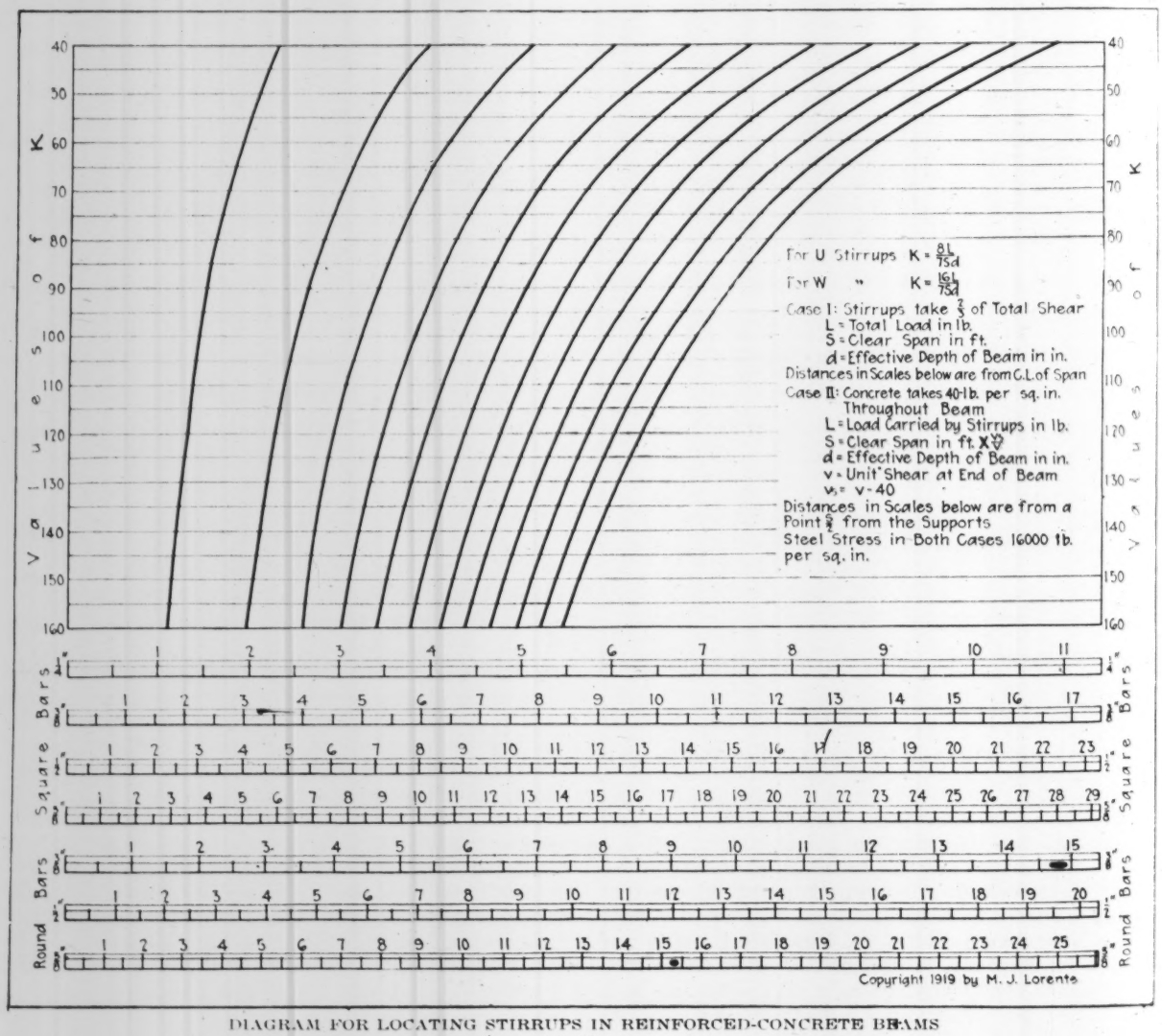

Values of K
For U Stirrups K = 8L/7Sd
For W " K = 16L/7Sd
Case I: Stirrups take 2/3 of Total Shear
L = Total Load in lb.
S = Clear Span in ft.
d = Effective Depth of Beam in in.
Distances in Scales below are from C.L. of Span
Case II: Concrete takes 40 lb. per sq. in. Throughout Beam
L = Load Carried by Stirrups in lb.
S = Clear Span in ft. X
d = Effective Depth of Beam in in.
v = Unit Shear at End of Beam
v1 = v - 40
Distances in Scales below are from a Point 1/4 from the Supports
Steel Stress in Both Cases 16000 lb. per sq. in.
Square Bars
Round Bars
Copyright 1919 by M. J. Lorente

DIAGRAM FOR LOCATING STIRRUPS IN REINFORCED-CONCRETE BEAMS

cate matters so much that an approximation is justified. Accordingly, the stirrup is located in such a way that it lies in a line $p\ q$, dividing the area $c\ b\ d\ e$ into two equal parts. In practice, it will be found that the location thus obtained varies but little from the location in a line passing through the centroid of the area mentioned, and that the difference is negligible.

Therefore, the location of the nth stirrup is given by the side along the line $A\ B$ of a triangle representing the shear carried by $n - \frac{1}{2}$ stirrups.

Now, let the shear at p equal V

Then the unit shear at p equals $v = \frac{V}{jdb} - \frac{wx}{12\,jdb}$

where b = width of beam, in inches;
d = depth of tension steel from top of beam in inches;
jd = moment arm of section, in inches;
and x = distance, in inches, from center of span to nth stirrup.

The total shear up to the point p, taking $j = \frac{7}{8}$, will be

$$\frac{wx^2}{21\,d}$$

and this shear must be equal to $(n - \frac{1}{2})\ a_s f_s$,
where n = number of stirrups up to the point p;
a_s = cross-sectional area of each stirrup, in square inches;
f_s = stress allowed in stirrups, in pounds per square inch.

We then have the equation $\frac{wx^2}{21\,d} = (n - \frac{1}{2})\ a_s f_s$,

which, if we let $\frac{w}{d} = y$ becomes $\frac{x^2 y}{21} = (n - \frac{1}{2})\ a_s f_s$,

therefore,

$$x = \sqrt{\frac{21(n - \frac{1}{2})a_s f_s}{y}}$$

If we follow the recommendations of the Joint Committee and allow the stirrups to take two-thirds of the shear, then this equation becomes

$$x = \sqrt{\frac{63(n - \frac{1}{2})a_s f_s}{2y}}$$

If, on the other hand, we allow the concrete to take v_c lb. per square inch throughout the beam, then x will be the distance of the stirrup from a point $\frac{S}{2} \times \frac{v - v_c}{v}$ from each support, where S = clear span and v = unit shear of beam at supports.

The accompanying curves have been worked for both methods of distribution for a steel stress of 16,000 lb. per square inch. Similar curves could easily be worked out for other stresses.

The best way to use the curves is to mark off on a piece of paper the intersections of the curves with the horizontal line at the proper value of the constant K, then read these marks on the scale corresponding to the size of stirrups it is desirable to use.

Manganese Exports From Brazil

Manganese exports from Brazil during the first two months of 1919, according to a recent consular report, amounted to 59,270 metric tons, compared with 71,101 metric tons in the corresponding period of the year 1918.

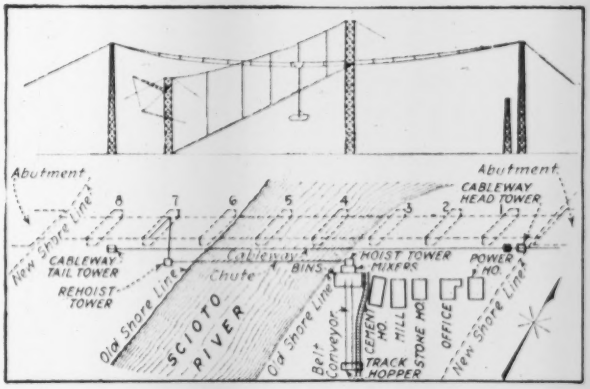
Electricity Cuts Construction-Plant Power Costs

Plant for Large Arch-Bridge Construction Motor-Operated—Motor Generator Permits Use of High-Tension Current

LOWER costs are being cut by electric operation of the construction plant for the nine-span concrete-arch bridge over the Scioto River at Columbus, Ohio. A motor generator, receiving alternating current at 4400 volts, generates 220-volt direct current for the machine motors. A 250-kw. generator supplies current for some 13 motors varying in size from 5 hp. for small machines to 65 hp. for the main cableway. Sawmill, belt conveyor, concrete mixers, derricks, pumps, piledriver, cableway and concrete-hoist towers are all electrically operated. Firemen and coal piles are eliminated except for one small boiler which supplies steam to a hammer for driving and pulling steel sheet piles for the cofferdams.

The bridge being constructed is located at Mound St. in Columbus, and is a portion of the work of widening the Scioto River to reduce the danger from floods. It is a heavily reinforced barrel-arch structure on two abutments and eight piers, and has the remarkable skew of 45°. There is 24,765 cu.yd. of concrete to be placed. When the channel is widened all nine arches will be waterway, but now the abutment and three piers at each end are on shore, although all have to be constructed in cofferdams.

All large units of the construction plant, as is shown by the sketch plan, are located on the east shore, on

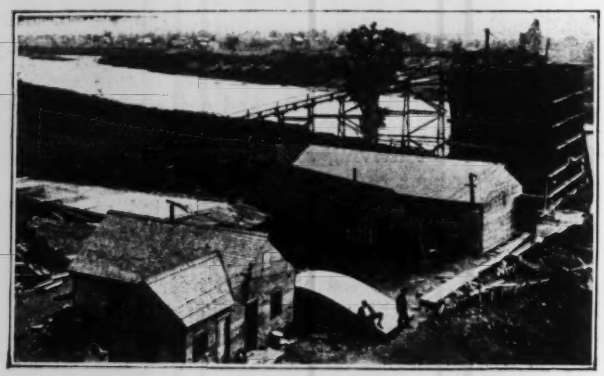


SYSTEM FOR HANDLING CONCRETE ELIMINATES DELAYS

ground which is finally to be removed. On the west shore are the tall tower of the cableway, the rehoist tower and derricks and pumps, and a mixer used on the west-shore abutment and piers. The derricks, piledriver, pumps, etc., are not indicated on the sketch, as their locations change as the work progresses. As indicated, two longitudinal conveying systems are provided. The first is an 800-ft. cableway which will handle and help erect form units and whose chief purpose is to shift from span to span the steel center ribs. Whenever necessary, the cableway can also handle concrete buckets from the central mixing plant. On most occasions, however, concrete will be distributed by the second of the two conveying systems, which is a main and a rehoist tower and chutes. The double means of

distributing concrete was a safeguard thought to be warranted by the requirement that the arches be poured in longitudinal sections. Two mixers are provided for the same reason; generally one will merely stand by, but it can be switched into operation at any time.

Sand and gravel are brought in cars on a switch track which extends to the cement house. Four cars can be stored on this switch between the track hopper and the cement house and, as the track is on a grade, can be dropped back by gravity and unloaded into the track hopper. In case the rail deliveries fail, materials can be delivered by truck to the track hopper. The hopper feeds into a 16-in. belt conveyor which ascends on a



BELT CONVEYOR ASCENDS FROM TRACK HOPPER TO GRAVEL BINS

trestle to the bin tops. The bins store 250 cu.yd. of sand and 500 cu.yd. of gravel, and chute by gravity into the mixers. A 15-hp. motor operates the conveyor. One mixer is a 1-cu.yd. machine with a 20-hp. motor and the other is a ¾-yd. with a 15-hp. motor. Either mixer can chute into the hoist bucket or to one side of the tower into the cableway bucket. The main tower will chute directly into the center and east shore spans. For the arches across the river, the main tower will chute to a rehoist tower and that in turn will deliver by swinging chute.

Steel centers and wood pier forms are employed. Centers for two half arches are provided, and when the right half of the arch is completed each half center is

CABLEWAY HANDLES CENTER AND PIER FORMS

rolled into position under the second half of the arch. When this is completed the centers are rolled out from under and are transferred ahead by the cableway to the next spans. A 65-hp. motor operates the cableway so that it can handle quite large form units and thus reduce dismantling to a mimimum. Wood forms are built on the job, there being a sawmill and a large assembling platform for framing the various units, with curved surfaces for umbrella piers and pier noses.

Reduction of power costs by using electricity is a matter of estimates. A power bill of $400 to $500 per month will, the contractor has figured, carry the work. The single boiler plant for the steam hammer which drives and pulls sheeting costs $10 per day for fuel and fireman. Separate steam plants would be required for all machines, owing to their wide separation, and each, it is calculated, would cost no less for fuel and attendance than does the pile-hammer outfit.

The plant layout was planned by the contractors, the Hickey Bros. Construction Co., of St. Louis, Mo.

State Control of Public Bathing Places

THE sanitary control of all swimming pools and public bath-houses in Florida, whether privately or municipally owned, is placed under the Florida State Board of Health by recent legislation (Florida laws, Chap. 7825, 1919). The law is based, in part, upon studies made by George W. Simons, Jr., chief sanitary engineer, state Board of Health, acting as chairman of the American Public Health Association's committee on swimming pool sanitation, but it is patterned after the law of California, which Mr. Simons says is, so far as he knows, the only other state which has such a law. Under the Florida statute no swimming pool, public bath-house, bathing or swimming place may be constructed, altered or operated without "an unrevoked permit" from the state Board of Health. Before such permit shall be granted, plans, specifications, and full operating details must be filed with the board. Information must be given as to the source of water-supply, its amount and quality, the proposed method of treating and heating the water and of providing for the cleanliness of bathers, the method of washing and storing bathing suits and towels, and any other data that the board may require. The board is authorized to inspect bathing and swimming places at any reasonable time, and in its discretion may publish the results of the inspections in its monthly bulletin. It may revoke or suspend permits for cause, and likewise may declare and bathing establishment a public nuisance, which nuisance may be abated or enjoined by either the state or local board of health. Violators of the act are subject to fines of $25 to $500, or to imprisonment in a county jail for not more than six months, or to both fine and imprisonment.

Motor Vehicles in Pennsylvania

Motor vehicles have increased greatly in Pennsylvania during the past five years, as is shown by registrations under the new motor-vehicle law. These show the following numbers for the year 1919:

Pneumatic-tire vehicles	402,797
Solid-tire vehicles	36,475
Tractors	2,619
Trailers	1,200
Motorcycles	23,021

The total receipts from all sources under the motor vehicle law in 1919 are $4,598,350.

Miami Flood Works Involve Radical Railway Changes

Railways Crossing Flood-Retarding Basins Shifted to High Ground—Levees Guard Stretches Crossing Low-lying Areas

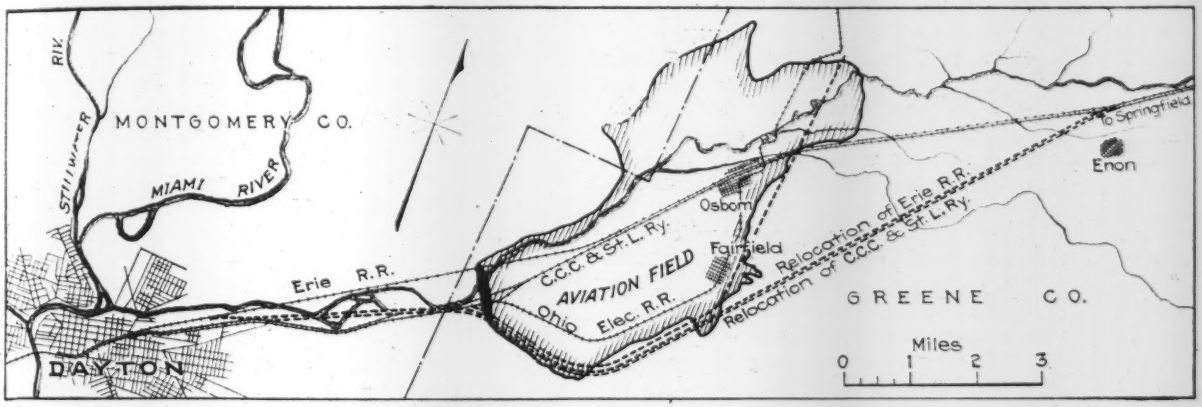
RAILWAY relocation is a large problem in the task of securing safety from floods for the towns of the Miami Valley in Ohio. Railways crossing the flood-retarding basins are being swung aside several miles and lifted above the reservoir flow lines. At places where complete clearance is impracticable, parallel levees embrace the roadbed and isolate it from the flood waters on both sides. Long culverts under levees and roadbed will keep the water level the same and equalize pressures.

Few railway construction operations now in progress are larger than those being conducted in connection with the Miami Valley flood-control works. At the two retarding basins where major railway changes are in progress some 55 miles of trackage are affected. The quantities are, in round numbers, 40 miles of new roadbed, over 100 culverts and bridges, 500,000 cu. yd. of levee, 1,500,000 cu. yd. of cut and 1,300,000 cu. yd. of fill. Including compensation of the railways for increased mileage and curvature and for changed grades, the construction cost will be about $4,000,000.

Only two of the five retarding basins greatly interfered with railway lines. The Erie R. R., the Cleveland, Cincinnati, Chicago & St. Louis Ry., and the Ohio Electric R. R., all running northeast out of Dayton, traversed the dam site and the retarding basin at Huffman. The Baltimore & Ohio R. R., from Dayton directly north, crossed the west end of the Taylorsville dam and skirted the west edge of the retarding basin just inside the flow line of maximum floods. At either Huffman or Taylorsville, to proceed far with the dam construction would require that the railways be removed. At Huffman a temporary local removal has already been affected.

Since the placing of the new lines and the design of their roadbeds and works must coördinate with the elevations and the locations of the flood-control structures proper, they were determined by the conservancy engineers. For similar reasons it was essential that these engineers should also regulate the time, place, and general methods of construction. So far as the design and construction method had no influence on the new lines as an integral part of a system of flood-control works, they were left to the railway engineers, subject to the approval of the conservancy engineers in matters of economics. As to the work of construction, the plan is to let the owning companies perform the work through their own engineers and through contractors, subject to the approval of the engineers of the district, which pays the total cost. This general plan is departed from in certain instances, where the district is doing this work with its own forces.

At Taylorsville the problem of the Baltimore & Ohio R. R. relocation was not unusual. The old line skirted the west edge of the reservoir a little within the flow line of maximum flood. Broadly speaking, relocation consisted of building a new line higher up the valley slope. The change in level at the reservoir ranged from 5 ft. to 35 ft. Rather heavy grading was involved in crossing a close succession of ridges and tributary valleys; there were in the 52,000 ft. (9.85 miles) of new line 850,000 cu. yd. of cut and 711,000 cu. yd. of fill, or about 85,000 cu. yd. of excavation per mile. At the dam the new line crossing a bulge of the flow line is protected by levees. The location standards followed were: Width of double-track roadbed, 34 to 42 ft.; side slopes, 1 on 1½; maximum grade, 0.2% compensated; maximum curve, two degrees.



THREE RAILWAY LINES RELOCATED TO DETOUR HUFFMAN RETARDING BASIN

The larger problem of relocation was at Huffman. Here three lines of railway traversed the basin, cutting squarely across both ends of the dam site which extends, as shown by the contour map, between the two valley slopes of Mad River. (See next page.) To pick the tracks out of the valley and set them on high ground above flood level necessitated new gradients and new alignments adjusted to maximum economy, considering both operation and construction cost.

The determining factors as to gradient were the elevation of railway yards at East Dayton and the elevation (850) of the top of the dam about five miles northeast (upstream). The ruling gradient made it necessary to adopt a location reaching El. 840 at the dam, so that the track is 10 ft. below the dam crest and must be protected by levees. These extend upstream from the dam about 3500 ft., where the railroad reaches higher ground. Downstream (toward Dayton) the alignment must be adjusted to fit the ruling gradient. These were the broad requirements of relocation.

MAD RIVER
C.C.C. & St. L. Ry.
Ohio Elec. Ry.
OUTLINE OF PROPOSED DAM
Relocation of Springfield Pike
Relocation of Ohio El. Ry.
Relocation of Erie R.R. & C.C.C. & St. L. Ry.

CRITICAL POINT OF RAILWAY DETOUR AT SOUTH END OF HUFFMAN DAM

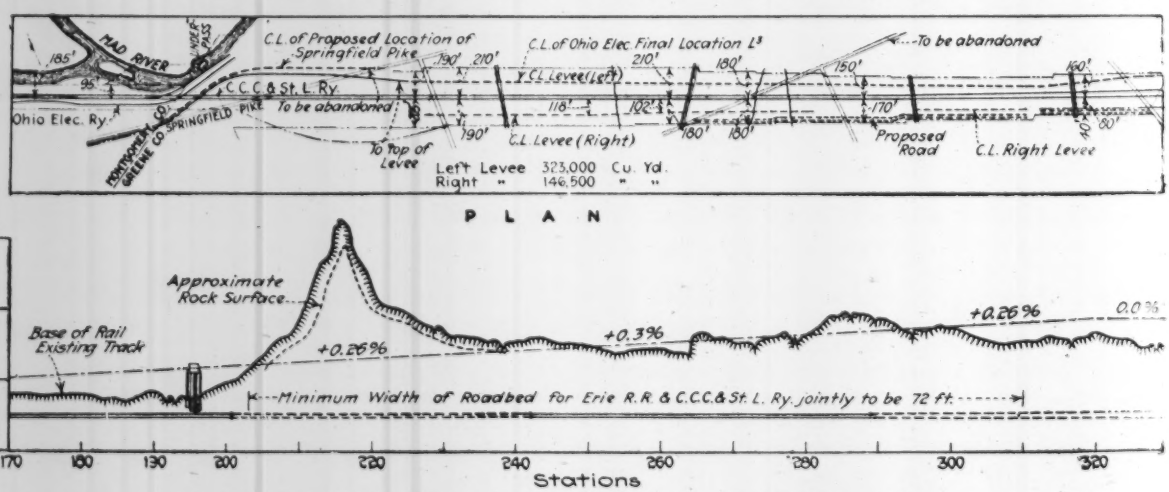
The original line locations are shown by the general map. Since the two steam lines had been for some time jointly operated as a double-track railway, it was possible, in planning their relocation, to consider them structurally as a double-track line on one roadbed. The logical detour was around the south end of the dam, that being the shortest, the least expensive in curves and gradients, and the one which best permitted the structures for all three roads to be bunched and thus reduce construction costs.

Some forty alternative alignments and profiles were compared before the final solution, giving maximum economy and safety from overflow, was reached. The problem was complex. A ruling grade of 0.3% could not be exceeded. Increases in milage and curvature, and grade changes beyond those of the original line, must be paid for. This was a very material factor, as is indicated by the fact that the 4000-ft. greater length and the 100° additional curvature, plus the grade changes, increased operating expenses by an amount which entitles the railways to $400,000 extra compensation. Above the dam for some distance the lines must come within the retarding basin and be protected by levees; the cost of earthwork in these levees, varying with changes in line and grade, introduced an additional factor in the normal problem of balancing cut and fill. Finally, there was the concentration of excavation in the heavy cut at the dam, of very nearly 75% of the total yardage of cut involved in the relocation, to be integrated with the factors of ruling grade and of safety from overflow of the line above the dam.

Beginning in the outskirts of Dayton, the Erie and the C., C. & St. L. lines are swung together as a double-track line on one roadbed and are carried at the grade of 0.3% to the hill at the dam. Here the Ohio Electric line is picked up, and for 2½ miles the three roads are kept together. The 4½-mile approach to the dam from Dayton is a continuous fill of 374,000 cu.yd., the grade of which strikes the hill at El. 810, which is 25 ft. below the elevation of the dam spillway and 40 ft. below its crest. Continuing the same grade, the line passes through the hill and between levees until El. 840 is reached. The profile shows in detail this critical section of the relocation. Throughout the 15 miles of new line the following standards are maintained: Width of single-track roadbed, 20 to 30 ft.; of double-track roadbed, 34 to 44 ft.; slopes, 1 on 1½ for earth, 1 on 1 for rock; maximum curve, 1°; maximum grade, 0.3%, compensated 0.04% on curves.

Both structurally and as a construction task, the striking portion of the new location lies between stations 200 and 310, a distance of slightly over two miles. To clear the dam, the steam-railway lines are swung about 400 ft. south of the new C., C. & St. L. Ry. location, into the hill, giving a cut about a mile long, with maximum depth of 119.8 ft.; the yardage is 680,000 cu. yd., of which about 80% is rock. From a point a few hundred feet above the dam, the cut is continued artificially in the form of parallel levees 200 ft. apart to station 310, where the grade on embankment between the levees has risen to El. 840. The crest elevation of the levees is 845, which gives a maximum depth of embankment at any point of about 35 ft. The northern levee, which also serves as a roadbed for the relocated line of the Ohio Electric R. R., is 20 ft. wide on top, the opposite levee 20 feet.

The excavation of the large cut is the governing operation in constructing the relocated lines. About 323,000 cu. yd. of the excavation is needed to construct



PROFILE OF TRIPLE-LINE PERMANENT WAY AT HUFFMAN DAM

the north levee, and the remainder for the south levee and the fills east and west of the cut. Steam shovels were put at work early in 1918, the shoveled material being hauled in dump-car trains onto the two embankments.

Much of the rock in the cut requires blasting to prepare it for the shovels. Much of it is shaky, and certain strata which are quite hard in the cut disintegrate on exposure, so that the rock forms a rather dense

ROCK CUT AT HUFFMAN DAM THREE-FOURTHS TOTAL EXCAVATION

embankment. To make sure that the north levee will be water-tight, however, it will be covered with a blanket of earth. At maximum progress the output has been between 30,000 and 40,000 cu. yd. per month. The general contractor, the Walsh Construction Co., of Davenport, Iowa, has handled the cut and the embankment formed from its spoil; the remainder of the grading it has let to subcontractors. On July 1 some 80% of the grading was finished. On the Baltimore & Ohio relocation at Taylorsville the general contractors, Grant Smith & Co., of St. Paul, Minn., and H. C. Kahl, of Davenport, Iowa, have sublet the team work and are doing the heavier grading themselves.

The structures on the new lines vary in size from pipe culverts to concrete arches and trestles up to 3500 cu. yd. They are all of heavy design, but present no particular features except in case of the long culverts under the roadbed between levees. These are more than 250 ft. long.

All railway relocating is under the direction of the Miami Conservancy District, Arthur E. Morgan, chief engineer; Charles H. Paul, assistant chief engineer, and C. H. Locher, construction manager. Albert Larsen, as division engineer, is in direct charge of all railway work.

Deliveries of Crude Domestic Petroleum

Deliveries to the trade of crude domestic petroleum in 1918, in barrels of 42 gal. each, totalled 380,242,153, according to reports prepared by A. B. Coons, under the supervision of E. Russell Lloyd, of the United States Geological Survey. Crude petroleum marketed in the United States amounted to 355,927,716 barrels.

License Surveyors in Texas

A BILL has been passed and signed by the Governor of Texas licensing land surveyors. The law becomes effective Oct. 21, 1919. The provisions of the law, as set forth by State Land Commissioner J. T. Robinson, are as follows:

"The surveyor's act creates a Board of Examiners of Land Surveyors to be composed of the Land Commissioner and two surveyors of 15 years' experience who shall be appointed by the Governor.

"The board will prepare questions pertaining to land surveying generally and the law of land boundaries. The examinations will be conducted by the county boards of examiners of applicants for teachers' certificates, but the surveyor's board will grade the answers and issue licenses. A surveyor's license will be good for life, unless revoked for improper conduct. Applicants will pay a fee of $10, of which $2 will be retained by the county board, and so much of the remainder as may be necessary will be used to defray the expenses of the surveyors' board.

"When a surveyor receives a license he will be authorized to do surveying work, public or private, anywhere in the state, and his work may be recorded and have the same authority as that of the county surveyors. This act does not in any respect affect county surveyors or their deputies, though a licensed surveyor may be elected county surveyor, but when so elected he may perform work outside his county.

"These licensed surveyors and county surveyors may charge a fee not to exceed $10 a day and expenses.

"Surveyors who have been actually engaged in the field for 15 years may, upon payment of a fee of $2, obtain a surveyor's license without examination."

At present the county surveyor's records are the only ones that are accepted for state and county records and in courts. The new law is expected to remove the monopoly held by county surveyors, for corporation men, if they have been licensed, may prepare records for court evidence. With the oil development of the state, there is considerable work of this nature.

Slag Concrete in England

Slag as an aggregate in concrete is just being developed in Gerat Britain. While there has been a great deal of very good concrete made from this aggregate, apparently there have been some difficulties which are recounted in a paper before the Cleveland Institution of Engineers by Dr. J. E. Stead. Dr. Stead said that poorly made concrete, when slag is used, is particularly dangerous below water because of the deleterious effect of water on the slag. He said, too, that often when the fines from old slag dumps are used they contain coal ashes and other deleterious substances, which ought to have been sieved off. In fact, he thinks that it is better to throw out all material passing a ½-in. mesh, or, better, a 1-in. mesh, for this will generally take care of the coal ashes, which contain sulphides of iron that produce acid solutions which react on the slag in the presence of air and water. This dissolves a portion of the alumina and lime in the cement, producing an aluminum calcium sulphate which may cause expansion. The investigator reports that such expansion has actually occurred where trouble has not been taken to remove the fine slag.

Bolts in Field Connections of Steel-Frame Buildings; a Study of Data and Experience

By R. Fleming
Engineer for American Bridge Company, New York City

Marked economy in construction may be realized through the substitution of bolting for the much more costly field riveting of steelwork; yet riveting is very commonly specified, because of doubts concerning the strength and permanent tightness of bolted connections. With a view to supplying data for more definitely grounded engineering practice, "Engineering News-Record" requested Mr. Fleming to collect and interpret the existing information and experience concerning field bolting. The results of this investigation are printed herewith. They tend to establish a far wider field for the use of bolts than present practice recognizes.—Editor.

RECENT specifications for steel-frame buildings commonly include a paragraph similar to: "Field connections shall be riveted throughout. No bolt shall be used in place of a rivet except by special permission of the engineer." The purpose of this article is to present a consideration of the subject of bolted field connections and to show that at times there are advantages in using them instead of connections that are riveted.

Bolted Mill Building 30 Years Old—The rolling mill of the Crucible Steel Co. at Harrison, N. J., now being torn down to give place to a larger structure (illustrated in *Engineering News-Record* of May 8, 1919, p. 898), was built in 1888-9. It is 190 ft. wide by 266 ft. 9 in. long, outside of brick walls. Roof trusses are from 12 to 15 ft. apart, 19 bays in all. The roof is of corrugated iron resting on angle purlins. A cross-section is shown in Fig. 1, and details of the field connections in the 75-ft. roof truss in Fig. 2.

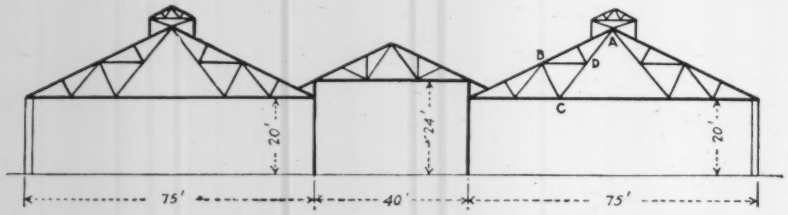


FIG. 1. CROSS-SECTION OF OLD ROLLING MILL OF CRUCIBLE STEEL CO. HARRISON, N. J.; FIELD CONNECTIONS BOLTED

Rivets are ⅞ in. and open holes 11/16 in. in diameter. Field connections were made with ⅞ in. buttonhead iron bolts. Not a field rivet was driven during the erection of the entire structure. Driftpins were used, evidently, to bring holes to match, as no reaming was done.

After 30 years' service the steel frame is apparently in as good condition as when erected. In this instance, then, nothing was lost in efficiency by having the field connections bolted throughout. It should be said that the trusses carry no shafting and are subject to but little vibration.

Bolts in a Railroad Viaduct—A striking use of bolts is in a railroad viaduct, the strengthening of which is the subject of an article in the *Journal of the Western Society of Engineers*, Dec., 1913. In 1888 the Chicago & Western Michigan R. R. built a wrought-iron single-track viaduct 1170 ft. long, designed for a loading practically equal to Cooper's E25. In 1912-1913 the structure was strengthened for E50 loading. The engineer of the work and writer of the article referred to, W. T. Curtis, tells the interesting story:

> The old structure was field-bolted (with the exception of buck and lateral bracing between the girders), a fact which was not discovered until after the field work of reconstruction had been begun. Careful investigation showed the old structure to be in perfect alignment, with none of the bolts loose in the slightest degree. As a matter of fact, many of the buck and lateral connections, which had been riveted originally, were found to be in bad shape on account of loose rivets. . . . While it was realized that the points which had been riveted in the old structure were points subject to more severe service than the points which had been bolted, the investigation satisfied all that participated in it that bolts are in reality much better than they are generally considered in ordinary practice.

It may be added that the bolts in the original structure were left undisturbed and are still in service.

Relative Costs—At the present time the cost of riveting is forming a larger proportion of the cost of erection than ever before. An average ratio of 2 to 1 is close to the relative cost of riveting and bolting in a steel-frame building. The ratio of cost of one rivet

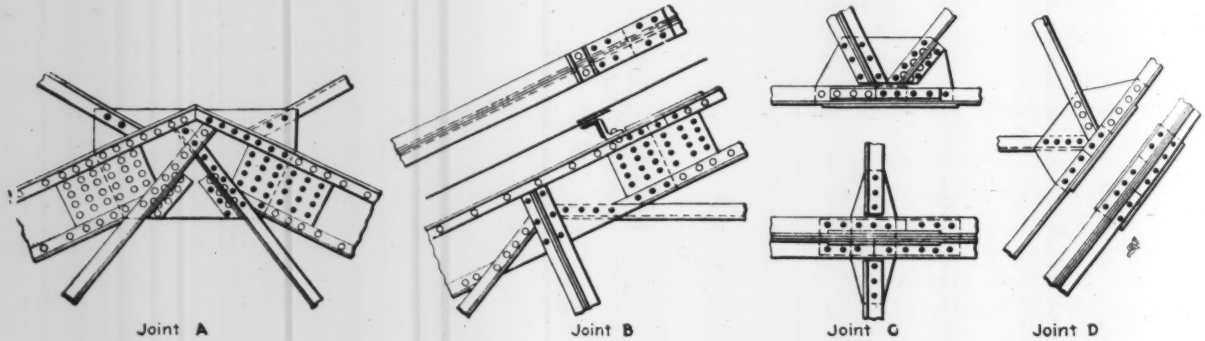


FIG. 2. DETAILS OF MAIN FIELD JOINTS IN 75-FOOT TRUSS OF OLD ROLLING-MILL ROOF TRUSSES

to one bolt at the intersection of angle bracing midway between trusses is about 8 to 1 for single-hole connections and 4 to 1 for three-hole connections. For attaching purlins to roof trusses, with a single hole at each end of purlin, the ratio of cost is about 5 to 1. Conditions vary so much that it is difficult to state actual costs, but the above ratios are given by the erection manager of one of the largest fabricating companies. The first cost of bolts above that of rivets need not be considered; it is soon absorbed in the lessened cost of erection.

In addition to lessening the cost of erection, the use of bolts saves time. This was recognized in the specifications for the three towers of the U. S. Government Radio Station at Darien. These towers are each 600 ft. high, and their tension as well as compression members are structural shapes. To facilitate erection the specifications allowed the bolting of all field connections, provided the members were assembled and reamed in the shop. The punching of holes not over $\frac{11}{16}$ in. was permitted, the reamed holes to be $\frac{13}{16} + d_1 = 53/64$ in.; the use of turned bolts not less than 53/64 — 1/50 in. in diameter was required for field bolting. Such specifications, however, would practically prohibit the use of bolts for field connections in steel frames of ordinary buildings.

As to Turned Bolts—By "turned" bolt is usually meant a bolt turned to a desired diameter in a lathe. The necessity of using such bolts in reamed holes has been magnified. The result sought is that bolts should have a tight fit. When the ordinary commercial bolt will not answer, "cut" bolts can be used. These bolts are "cut" or turned by pushing an ordinary bolt into a series of revolving cutters set to the desired diameter. The relative costs of ordinary, "cut" and "turned" bolts are 3 to 7 to 10. A provision found in a former New York building code and in many present codes is:

> Turned bolts in reamed holes shall be deemed a substitute for field rivets.

The paragraph on bolted connections in Johnson, Bryan and Turneaure's "Modern Framed Structures, Part III, Design," 1916, says:

> Occasionally, permanent connections are made by the use of bolts, in which case the bolts are accurately finished to exact dimensions. The holes must also be drilled to an exact fit with the bolts. Such joints are more reliable in direct tension than riveted joints and it may be questioned whether they would not be in general more reliable for field connections where the rivets are very long.

The book quoted treats mainly of bridge design. The present writer takes exception to any statement that in building work turned bolts in reamed holes are necessary for bolted connections.

Bolts and Rivets in Tension—Many specifications prohibit rivets in tension. Some add:

> Where it is necessary that connections take tension turned bolts shall be used.

The writer does not think it always necessary to substitute bolts for rivets in tension—the kneebrace, for instance. Neither is it necessary to use turned bolts; ordinary bolts will answer. In telpher and monorail systems it is usually necessary to connect the top flange of an I-beam to the bottom flange of another I-beam or to the bottom chord of a truss by rivets or bolts in direct tension. The writer believes that in this and similar cases bolts should be used. He would apply to suspended trolley systems a paragraph of the specifications in Godfrey's "Steel Designing" by changing it to read:

> Tension in *bolts* will be allowed only when the connection is symmetrical and contains at least four *bolts*. The bending at the heel of the connection angle must be considered as well as the bending on the part to which the detail is attached. Additional *bolts* must be provided to take any shear coming upon the same connection.

Other requirements that should be added are that the bearing for head and nut be at right angles to axis of bolt and that the load be distributed over as great an extent of area as necessary to prevent bending of bearing surface. Both these results may be accomplished by cast-steel washers or clamps. When the flanges are beveled the clamps should be beveled to fit, and they should have a greater superficial area when the flanges are thin than when they are thick. A detail of bolts and clamps is shown in Fig. 3.

The interests involved are sufficient to warrant frequent inspection of the bolts. A few years ago the

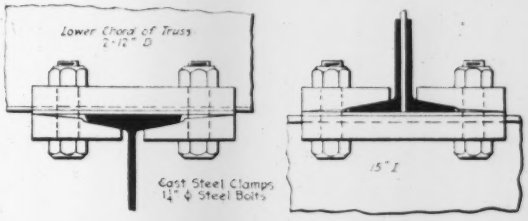


FIG. 3. CLAMPS ATTACHING MONORAIL BEAM TO TRUSS

A recommended example of practice. The monorail carries 3- and 5-ton loads; though the nuts are not locked they have required very little adjustment in five years' service

family of an operator who was killed by the failure of a telpher system from the bolts giving way recovered damages in the courts. (*Engineering News*, June 10, 1915, p. 1139.) It is interesting to note that before final failure of the faulty connection both rivets and bolts had been used. The rivets lasted a day or two, the bolts a week or two. While a comparison of the lasting qualities of bolts and rivets for this particular case is thus given, "the bolts undoubtedly gave way because they were highly overstressed, not alone by the direct load, but also by impact and the movement caused by the overhang of the end of the rail close to the switch joint."

The writer uses a working stress of 9000 lb. per sq.in. net section under the thread for bolt in tension. This stress is specified in the present New York building code. The previous code gave a value of 14,000 which was widely copied and unfortunately still remains the assigned value in many building codes.

Strength of Bolts—At the outset of any discussion of bolted joints it is important to know their strength. The amount of experimental data on bolted joints compared with that on riveted joints is small.

The *Cornell Civil Engineer*, May, 1915, contains a description of a series of tests on beam connections made in the College of Civil Engineering of Cornell University. The purpose of the tests was primarily to determine whether or not satisfactory beam connections could be made with fewer web rivets than were required by the standards then in use, but incidentally the outstanding legs of the connection angles were attached to the supports by machined bolts turned to make a driving fit in $\frac{13}{16}$-in. reamed holes.

Because of this the test was actually a test of bolted connections, the manner of final failure in most of the tests being by shearing of the bolts. This occurred at stresses of from 44,700 to 52,400 lb. per sq.in. of bolt section. But machined bolts turned to make a driving fit in reamed holes are seldom used in ordinary building work.

TABLE I. STRENGTH OF RIVETS AND BOLTS, WATERTOWN ARSENAL TESTS, 1896

Pieces Connected	Number of Rivets or Bolts	Steel Rivets Tension	Iron Rivets Tension	Steel Bolts Tension	Steel Bolts Shear	Iron Bolts Tension	Iron Bolts Shear
2 plates 3½x⅜	2—⅞	26,990	26,120	21,110	45,030	18,690	39,660
2 plates 5½x⅜	3—⅞	29,590	24,310	21,460	46,310	18,090	38,920
2 plates 7x½	4—1	28,820	26,450	22,060	45,940	20,470	43,310
1 web 4x¼ and 2 covers 4x¼	2—¾	*29,540	29,670	20,050	35,780	18,000	32,440
1 web 6x¼ and 2 covers 6x¼	3—¾	31,040	28,520	25,010	44,920	17,720	31,260
1 web 8x¼ and 2 covers 8x¼	4—¾	*28,970	28,470	23,440	41,840	18,990	34,110
2 plates 6x¼	12—⅝	.....	39,600	.....	.....	26,490	32,310
2 plates 6x½	6—¾	.....	32,880	.....	.....	17,740	29,600
2 plates 7½x⅝	8—⅞	.....	*34,350	.....	.....	22,410	34,960
2 plates 9x½	10—⅞	.....	*35,940	.....	.....	19,000	28,770
2 plates 8x¼	6—⅞	.....	.....	.....	.....	32,700	38,110
2 plates 10x¼	8—⅞	.....	.....	.....	.....	34,840	37,220
1 web 9¼x¼ and 2 covers 9¼x¼	8—¾	.....	36,300	.....	.....	23,390	34,370

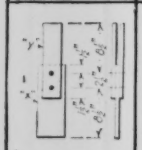
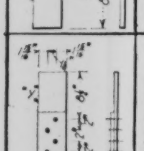
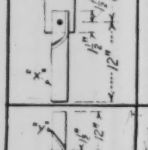
Under "Tension" is given the load applied (in lbs. per sq.in. of gross section of plate) that produced failure.
Under "Shear" is given the shearing strength of bolts in lbs. per sq.in. of bolt section.
In all cases except those marked * failure occurred by the shearing of bolts or rivets.
* Plate fractured.

Watertown Tests—An extensive series of tests of riveted and bolted joints for the Berlin Iron Bridge Co., of East Berlin, Conn., was made in 1896 at the Watertown Arsenal. (*Tests of Metals*, 1896, pp. 277-339.) The tests were made to determine the shearing strength of rivets and bolts. The pieces connected were of steel; the holes were punched with a punch $\frac{1}{16}$ in. and die $\frac{1}{8}$ in. larger than the diameter of the rivet or bolt. Ordinary bolts with button heads and hexagonal nuts without washers were used. The results of the 24 tests of $\frac{3}{4}$-in. rivets and bolts and a dozen of the 27 tests of $\frac{5}{8}$-in. iron rivets and bolts are given in Table I herewith. All $\frac{3}{4}$-in. rivets and bolts and the twelve $\frac{5}{8}$-in. rivets and bolts in the 6 x $\frac{1}{2}$-in. plates were in a single row; the remaining rivets and bolts were in double rows. As so many of the tests were of iron rivets and bolts the table is of value at the present time mainly for comparative study. It will be seen that practically the same pull produced failure in both steel and iron rivets, while the pull producing failure in steel bolts was 20% greater than in iron bolts. The shearing value of the bolts, while somewhat erratic, is no more so than that of the rivets. It should be noted that although the number of bolts in a connection varied from 2 to 12, in no case was the shearing value such as to lead to apprehension concerning working stresses for bolted connections.

Bolts in Transmission Towers—Field connections of ordinary towers for high-tension transmission lines are almost invariably bolted. For crossings over railroads and navigable streams, specifications are not uniform. Some railroad engineers require that the towers supporting a span over tracks be riveted even when the material is galvanized, though riveting destroys the galvanizing around the heads of rivets, and gives a less efficient structure. In some of the U. S. Engineer districts riveting is required for crossings over navigable streams, while in other districts bolting is allowed. This emphasizes the vagueness of technical opinion regarding the value of bolted and riveted connections.

A series of tests was made in 1915 at the testing laboratory of the Carnegie Steel Co., Pittsburgh, by J. B. Leeper, manager of the tower department, American Bridge Co., to determine the strength of ½-in. and ⅝-in. bolts such as are used in transmission towers. (The writer is indebted to Mr. Leeper for a copy of his report on these tests). The purposes of the tests were to determine the ultimate bearing and shearing values of the bolts and to determine if the bolted connections showed any signs of stresses.

TABLE II. TESTS OF TRANSMISSION TOWER BOLTS

Make-up of Test Pieces	Test No.	Material End "X"	Material End "Y"	No. and Size of Bolts	Breaking Load (Lbs.) Total Load	Unit Bearing	Unit Shear
	A1	1 bar 4x¼ x1′-0½″	2 bars 3x⅜x1′-0½″	2—⅝″φ	24,900	*145,500	20,300
	A2	1 bar 4x$\frac{3}{16}$x1′-0½″	2 bars 3x⅜x1′-0½″	2—⅝″φ	32,900	*142,100	26,800
	A3	1 bar 4x¼ x1′-0½″	2 bars 3x⅜x1′-0½″	2—⅝″φ	39,000	*124,800	31,800
	A4	1 bar 4x⅜ x1′-0½″	2 bars 3x⅜x1′-0½″	2—⅝″φ	48,100	62,000	†29,200
	A5	1 bar 4x⅜ x1′-0½″	2 bars 3x⅜x1′-0½″	2—½″φ	22,500	*170,500	28,600
	A6	1 bar 4x$\frac{3}{16}$x1′-0½″	2 bars 3x⅜x1′-0½″	2—½″φ	27,900	*155,000	†35,550
	A7	1 bar 4x¼ x1′-0½″	2 bars 3x⅜x1′-0½″	2—½″φ	27,600	*110,400	†35,200
	A8	1 bar 4x½ x1′-0½″	2 bars 3x⅜x1′-0½″	2—½″φ	27,100	53,600	†34,550
	B1	1 bar 4x⅜ x1′-0½″	1 bar 4x½x1′-0½″	2—⅝″φ	23,400	*138,700	†38,200
	B2	1 bar 4x$\frac{3}{16}$x1′-0½″	1 bar 4x½x1′-0½″	2—⅝″φ	22,900	*100,600	†37,300
	B3	1 bar 4x¼ x1′-0½″	1 bar 4x½x1′-0½″	2—⅝″φ	22,700	*71,100	†37,000
	B4	1 bar 4x$\frac{3}{16}$x1′-0½″	1 bar 4x½x1′-0½″	2—⅝″φ	24,270	61,500	†39,600
	B5	1 bar 4x⅜ x1′-0½″	1 bar 4x½x1′-0½″	2—½″φ	13,900	*107,000	†35,400
	B6	1 bar 4x$\frac{3}{16}$x1′-0½″	1 bar 4x½x1′-0½″	2—½″φ	13,350	*73,300	†34,000
	B7	1 bar 4x¼ x1′-0½″	1 bar 4x½x1′-0½″	2—½″φ	13,100	52,400	†33,400
	C1	1 bar 5x⅜ x1′-6″	1 bar 5x$\frac{7}{16}$x1′-6″	3—⅝″φ	25,050	*111,300	27,250
	C2	1 bar 5x$\frac{3}{16}$x1′-6″	1 bar 5x$\frac{7}{16}$x1′-6″	3—⅝″φ	28,400	*94,600	30,850
	C3	1 bar 5x½ x1′-6″	1 bar 5x$\frac{7}{16}$x1′-6″	3—⅝″φ	36,100	78,600	†39,200
	C4	1 bar 5x⅝x1′-6″	1 bar 5x$\frac{7}{16}$x1′-6″	4—⅝″φ	44,100	55,100	†35,900
	C5	1 bar 5x⅜ x1′-6″	1 bar 5x$\frac{7}{16}$x1′-6″	4—½″φ	26,900	*107,600	†34,200
	C6	1 bar 5x$\frac{3}{16}$x1′-6″	1 bar 5x$\frac{7}{16}$x1′-6″	5—½″φ	34,650	*81,500	†35,200
	C7	1 bar 5x¼ x1′-6″	1 bar 5x$\frac{7}{16}$x1′-6″	5—½″φ	35,600	58,100	†36,250
	D1	1L2x2x¼ x1′-1½″	1 bar 4x½x10″	1—⅝″φ	9,050	*120,600	29,500
	D2	1L2x2x$\frac{3}{16}$x1′-1½″	1 bar 4x½x10″	1—⅝″φ	11,300	*93,600	†36,800
	D3	1L2x2x¼ x1′-1½″	1 bar 4x½x10″	1—⅝″φ	10,900	*69,800	†35,700
	D4	1L2x2x$\frac{5}{16}$x1′-1½″	1 bar 4x½x10″	1—⅝″φ	10,300	57,800	†33,600
	D5	1L2x2x⅜ x1′-1½″	1 bar 4x½x10″	1—½″φ	7,050	*117,500	†35,900
	D6	1L2x2x$\frac{3}{16}$x1′-1½″	1 bar 4x½x10″	1—½″φ	6,600	*71,400	†33,600
	D7	1L2x2x¼ x1′-1½″	1 bar 4x½x10″	1—½″φ	6,870	55,000	†35,000
	E1	1L2x2x¼ x1′-3½″	1L2x2x¼ x1′-3½″	2—⅝″φ	19,120	*122,200	31,200
	E2	1L2x2x$\frac{3}{16}$x1′-3½″	1L2x2x$\frac{3}{16}$x1′-3½″	2—⅝″φ	21,700	*94,750	†35,400
	E3	1L2x2x¼ x1′-3½″	1L2x2x¼ x1′-3½″	2—⅝″φ	21,850	*71,400	†35,600
	E5	1L2x2x⅜ x1′-3½″	1L2x2x⅜ x1′-3½″	2—½″φ	13,500	*112,500	†34,400
	E7	1L2x2x¼ x1′-3½″	1L2x2x¼ x1′-3½″	2—½″φ	13,800	56,400	†35,200

* Holes elongated.
† All bolts sheared or were about to shear.

yielding when subjected to a pull corresponding to 20,000 lb. per sq.in. shearing and 40,000 per sq. in. bearing stress.

Usual shop practice was followed in punching the test-pieces, the holes being $\frac{1}{16}$ in. larger than the nominal diameter of the bolts. The plates had an ultimate tensile strength of 60,000 to 70,000 lb. per sq.in., the angles 55,000 to 65,000 lb. per sq.in.; the bolts, taken from stock, were made from openhearth steel with an ultimate tensile strength of 55,000 to 65,000 lb. per square inch.

The make-up of pieces and the breaking loads are shown in the accompanying Table II (see preceding page). The unit values were computed from actual dimensions.

Bearing values are best determined from those marked by an asterisk, denoting that the holes elongated. The average bearing value per bolt for 38 bolts in 18 test pieces (the values for A1, A2, A3, A5, A6 and A7 are not included, for the reason that the test pieces are held between two heavier pieces and do not give fair averages) is 95,048 lb. per sq.in. It will be seen that the unit bearing values for individual tests are erratic; the wide variation was caused by the piling up of metal under the bolt as the hole elongated.

The unit shear values marked by dagger are for those cases in which all the bolts failed by shearing or were "about to shear." The average shearing value per bolt for the 49 bolts in 22 test pieces in single shear is 35,853 lb. per sq.in. It may be noticed that the unit shearing values for one and two-bolt connections are about the same as for three- four-, and five-bolt connections.

In making the tests the loads were applied gradually and as uniformly as practicable, keeping the beam of the testing machine balanced. When the test load had reached the predetermined load equivalent to 20,000 lb. shear and 40,000 lb. bearing, the motor was stopped for about a quarter of a minute to make sure the yield-point had not been reached. On account of the element of time necessary to stop the motor, it was difficult to stop always on just the predetermined load; the average unit bearing stress of 53 bolts was 40,826 lb., and the average unit shearing stress of 41 bolts was 20,760 lb. The test pieces showed no signs of reaching the elastic limit at these loads.

The recommendations made by Mr. Leeper are followed by the American Bridge Co. in the detailing of transmission towers. His report is quoted:

> We recommend that the following unit values of shear and bearing be considered as the so-called elastic limit of bolted connection: Shear, 22,000 lb. per sq.in.; bearing, 44,000 lb. per sq.in. We also recommend that the nominal ultimate unit shearing and bearing values be considered: Shear, 35,000 lb. per sq.in.; bearing, 70,000 lb. per sq.in.
>
> We further recommend that for tower connections the allowable unit shear for bolts be two-thirds the allowable unit tensional strain in the tension members and that the allowable unit bearing for bolts be double the allowable unit bolt shear. This recommendation is based on an elastic limit of 30,000 lb. per sq.in. for structural steel and 10/11 of the 22,000 lb. per sq.in. recommended elastic limit of bolt shear and 10/11 of the 44,000 lb. per sq.in. recommended elastic limit of bearing value of bolts. The reason for taking 10/11 of the so-called elastic limit values for bolted connections is to use values such that the bolted connections will be nominally 10% stronger than the members which they connect, up to the elastic limit.

On this basis bolt values will be as follows:

Allowable Tension, Lb. per Sq.In.	Bolt Shear, Lb. per Sq.In.	Bolt Bearing, Lb per Sq In
30,000	20,000	40,000
25,000	16,700	33,400
20,000	13,500	27,000
18,000	12,000	24,000
16,000	10,700	21,400

Bolts in Buildings—Are the foregoing recommendations applicable to bolted connections in buildings? It is noted that the shearing values of bolts are based upon the allowable tension and that for the commonly specified tension of 16,000 lb. the bolt shear is 10,700 lb. From the different natures of the two classes of structures it seems reasonable that the bolt values used in transmission towers be assumed greater than those used in building work. Schneider, in his "General Specifications for Structural Work of Buildings," assigns values in pounds per square inch as follows:

Tension, net section, rolled steel	16,000
Shear on rivets and pins	12,000
Shear on bolts and field rivets	10,000
Bearing pressure on pins and rivets	24,000
Bearing pressure on bolts and field rivets	20,000

Elsewhere in the specifications is a paragraph:

> Wherever bolts are used in place of rivets which transmit shear, such bolts must have a driving fit. A washer not less than ¼ in. thick shall be used under the nut.

When he wrote his specifications, Mr. Schneider has said in discussing this subject, he had in mind a bolt whose threaded portion was less in diameter than the unthreaded portion. Such a bolt could be driven without injuring the thread, but bolts of this kind are not listed in the trade catalogs of bolt manufacturers. They would have to be specially made at special prices.

Other specifications allow different values. Ketchum in his "General Specifications for Steel-Frame Buildings," 1916, also specifies for tension in main members 16,000 lb. per sq.in. net section and assigns a shearing value of 11,000 lb. and a bearing value of 22,000 lb. per sq.in. to shop rivets, two-thirds of these values to field rivets, and to field bolts, "when allowed," two-thirds the value of the field rivets. This gives a field bolt a shearing value of 4889 lb. and a bearing value of 9778 lb. per sq.in. (Rivets in lateral connections may have values increased 25%.) The bolt values of Ketchum are needlessly severe. It is doubtful if they are followed to any great extent.

The American Bridge Co. uses 9000 lb. per sq.in. shearing value and 18,000 lb. per sq.in. bearing value for bolts in building work. These values apply to ordinary commercial bolts, and holes punched $\frac{1}{16}$ larger than the diameter of the bolt. The writer considers these values well chosen.

Overtightening Bolts—Bolts of small diameter have sometimes broken off in screwing up the nut. "It is doubtful if the intensity of stress due to the initial load is fairly appreciated. The resultant load due to the combined action of the initial and external loads is one that is discussed periodically in technical journals with an invariable disagreement among the disputants as to conclusions." (From "The Stress on Bolts in Service," by John H. Barr, *Sibley Journal of Engineering*, Oct., 1902. See also "The Relation of Bolt Tension to Wrench Pull," *American Machinist*, Nov. 12, Dec. 17, Dec. 31, 1914). The matter is too academic for discussion in this article. Moreover. the best calculations may be

thrown into the scrap heap by a workman with a wrench.

It is possible to overstress a bolt in tension by turning the nut too tight, thus causing it to fail under apparently low unit stress. A practical method of limiting the initial stress is to limit the wrench handle to such a length as to make it impracticable to turn the nut too tight—say 9 in for ⅝-in. bolts and 10 in. for ¾-in. bolts.

In comparing rivets with bolts it should be remembered that the initial stress in rivets may be greater than in bolts. Experiments made a few years ago showed tensile stresses of 31,000 lb. per sq. in. in ordinary rivets parallel to the shank after they had cooled subsequent to being driven by a hydraulic riveting machine. Rivet heads sometimes snap off in cooling, also in extremely cold weather.

Looseness of Bolted Joints—The important question now, arises, When is it permissible, and when not, to use bolts in field connections? It is not altogether a question of strength. Riveted connections and bolted connections can be made of equal strength by increasing the number of bolts. The usual objections to bolts are: They do not fill the holes, resulting in a looseness at the joints which is particularly objectionable where there are alternating stresses; and it is uncertain how nearly uniform is the distribution of stress where there are a large number of bolts. The stiffness of the structure is thus affected, it is claimed, when members have bolted connections. The determining factor therefore should be whether or not the stiffness of the structure would be impaired to such a degree by the use of bolts as to render them objectionable.

It is believed that bolted connections are permissible for the following:

Buildings of one story, not of great height and acting mainly as shelters. Such buildings carry no shafting or electric traveling cranes and unless exposed to unusual winds there is little reason why field connections may not be bolted throughout.

Buildings for temporary use.

Subordinate framing such as that required for stairs, doors, windows, partitions, ceilings, monitors, pent houses, curbs and railing. It is often desirable, if not necessary, to have framing around windows, doors, skylights and similar work bolted in order to secure proper adjustment for the work of other contractors.

Purlins and girts, except where they form an integral part of a system of bracing. There is little reason why the clips to which purlins and girts are attached should not be shop-bolted, instead of shop-riveted, to main members. The same is true of many connections for subordinate framing.

Platform and floor plates. If there are trucks moving on the floor, or there is shoveling of coal or material, countersunk-head bolts should be used. An indentation in the head is convenient to hold a bolt while the nut is being turned. In other cases bolts with button heads not over ¼ or $\frac{5}{16}$ in. high may be used.

Connections of beams to beams and beams to girders in floors that do not support machinery, shafting or rolling loads. This is an important item in a many-storied office building or hotel. If the connections of floor members to columns are riveted the structure is stiff transversely and longitudinally. Little is gained in stiffness and much is added to expense by riveting connections of filling-in members. Moreover, in fireproof construction the bolts are embedded in concrete, a fact which should assure any doubter that there is no chance of nuts becoming loose. The specification for a 12-story apartment house in New York City has the clause: "All connections within 3 ft. of the column centers must be riveted. All tank and sheave beam supports must be riveted. Other connections may be bolted." In this particular building the beams upon which some columns depend for lateral stiffness do not connect directly to the columns, but frame a foot or two away into other connecting beams. Is not this a commendable clause for similar cases?

Bracing connections not subject to direct stress. This refers particularly to the intersection of bracing angles midway between trusses and columns. An over-zealous inspector will sometimes insist upon specifications being carried out to the letter and that rivets be used. This necessitates riveting from a special rigging at a cost of a dollar or two per rivet. The cost would not be a valid objection provided anything were gained by it.

Connections not subject to shearing stress at points where members rest upon other members.

The foregoing list is a conservative minimum. In many cases it may be extended.

Bolts have been used to a greater extent than allowed in specifications, and seemingly without harm. One instance is a power house 52 ft. by 270 ft., 33 ft. high to bottom chord, containing a 20-ton electric traveling crane. The owners were in a great hurry for the building, and, on the representation of the erector that bolting instead of riveting would hasten completion, instructed that all connections be bolted. As the writer was especially interested in the building he protested to the erector against bolts being used in certain connections and was promised that they would be replaced with rivets. More than four years have passed and the bolts are still in place—and to all appearance rendering efficient service.

Recommended Clause for Field Bolting—It is obvious that there are many places in which bolts should not be used. Connections of members with large stresses, column splices, members subject to vibration, and most bracing, should be riveted. The writer has endeavored to embody the spirit that should govern the use of rivets and bolts in field connections, in his specifications:

(98) In general, field connections shall be riveted, but connections of the following classes may be bolted:

a. Light subordinate framing such as purlins, monitor and skylight framing, girts, platforms, stair framing, partitions, ceilings, pent houses.

b. Ordinary framing of beams to beams and beams to girders.

c. Connections not subject to direct shearing stress.

All connections, however, affected by loads that cause undue vibration shall be riveted.

One-story buildings not subjected to excessive wind pressure or not supporting heavy concentrated loads, shafting or moving loads may be bolted throughout.

Many specifications require that washers be used under heads of all nuts. The washer permits a variation in the length of thread, allowing it to be long enough to assure the nut being screwed tightly against a bearing surface but not so long that it bears against the metal connected. But where no direct shear is transmitted or the shear is small or the metal so thick that full bearing is not required, the bearing of the thread does no harm. With this in view the writer has added to the portion of his specifications previously quoted:

The threaded part of a bolt transmitting shearing stress shall not be so long that the bearing value of the unthreaded portion is reduced to less than the shearing value of the bolt.

Washers shall be used wherever needed.

An objection may be made to specifying that washers shall be used "wherever needed," on the ground that the choice is left to workmen at the site. This is not the case. The bolt list is sent from the drafting room to the erector in charge. The lengths of bolts, lengths of thread and grip, whether washers are wanted or not, are determined by the draftsman.

For the same reason that the good appearance of a drawing goes far to inspire confidence in its accuracy, the neat appearance of a bolted connection tends to create confidence in its strength. A like thought was probably in the mind of the writer of the following drafting-room instructions:

In bolts for exposed work, specify hex. heads and hex. nuts for both shop and field bolts. Specify a length of bolt that will not give an excessive projection beyond the nut. There are cases where it is necessary to specify on which side of the member the heads of the bolts are to be placed.

Locking Nuts—The matter of nuts becoming loose has received much attention. It is often specified that nuts must be locked. The *Index of Patents Issued* indicates that about 2350 patents for nut locks and nut locking devices have been issued since 1900. New devices are still being brought forward.

Many times when bolts are considered perfectly locked there develops a slight looseness. This is usually attributed to nuts working loose. But a writer (John B. Seymour, of the National Lock Washer Co., in an article "Permanent Security of Bolted-Up Construction," in *Electric Railway Journal*, Nov. 22, 1913, p. 1104) claims that this is not the case. He says, "Tests have been made on practically every variety of bolted construction which conclusively demonstrate that looseness may occur without nut movement." Stretch of bolt and corrosion are also eliminated by this writer as causes of nut movement. He states what he thinks is the real cause: "Movement of bolted parts on each other occurs from end thrust, since it is commercially impossible to make all bolt connections to a theoretical driving fit. Where movement of objects in surface contact occurs, frictional loss must take place, and after the loss has taken place conditions are prepared for nut movement, stretch of bolt and corrosion."

Some "vibration-proof" bolts and nuts when tested at the Watertown Arsenal (*Tests of Metals*, 1895, 1897) did not by any means prove true to name. Evidently the only certainty that nuts of bolts subject to considerable vibration are kept tight is by frequent inspection and screwing them up if found loose.

For ordinary vibration two nuts are often used, one as a jam or lock nut for the other. The lock nut is usually one-half as thick as the ordinary nut and is placed on the outside. A split nut-lock washer underneath the nut is also frequently used.

Sometimes the thread is jammed to keep the nut from turning. A similar method for preventing the turning of nuts in towers for transmission lines has been used and has given excellent satisfaction. A chisel with either a diamond or a square point is driven by a sharp blow into the thread of the bolt just above the nut (see photographs in Fig. 4). The indentation prevents the nut coming loose under vibration but will not prevent its being taken off if such necessity should arise.

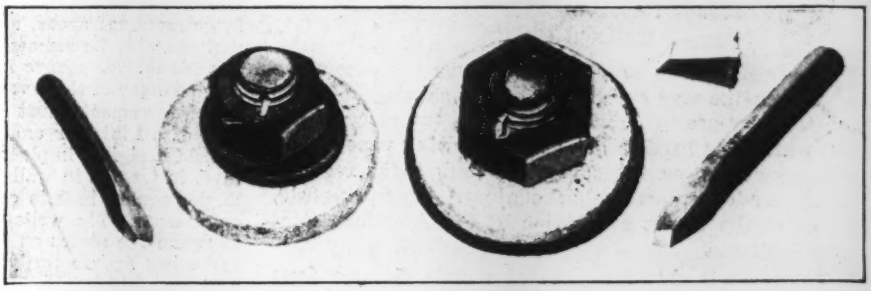


FIG. 4. NUTS LOCKED BY CHISEL CUT—STANDARD PRACTICE OF A LARGE BUILDER OF TRANSMISSION TOWERS

Two forms of chisel used, and their work (about one-half actual size.) The two forms are equally convenient and give equally secure locking. The field superintendent reports highly satisfactory results.

In conclusion: Bolted connections have a place in building construction. Each building should be considered by itself and advantage taken of the saving in time and cost by the use of bolted connections where they are unobjectionable and practicable.

Suggests Closing Chicago River to Navigation

Although the Chicago River is a link in the proposed waterway connecting the Great Lakes with the Mississippi River, its closure to navigation by substituting fixed bridges for drawbridges has been suggested by Col. W. V. Judson, Corps of Engineers, U. S. A., in charge of the Chicago district. Such a move would be accompanied by the establishment of a harbor on the lake front.

In a statement by Colonel Judson that was recently sent to public officials it is remarked that navigation on the river by lake vessels is declining and that the cost of drawbridges, with their maintenance and operation and delays to street traffic, is enormous and increasing. With regard to harbor facilities and the present ordinance for lake-front improvement, the statement implies that the Government may be more liberal in authorizing the creation of park lands by filling along the shore if the state agrees that certain of these park lands may revert to harbor purposes on demand of the Government. Reference is made to deep waterways connecting the Great Lakes and the sea (evidently meaning the Atlantic) and the possibility of Chicago becoming a seaport, but no reference is made to the westward waterway by way of the Chicago River and the Drainage Canal. The new lake-front ordinance does include a harbor reservation, but whether this is extensive enough to meet the ideas of the War Department cannot be determined until the ordinance is submitted to the department for its approval.

A somewhat similar idea expressed in regard to the Milwaukee River at Milwaukee, Wis., was described in *Engineering News-Record* of Sept. 27 and Oct. 18, 1917, pp. 608 and 722, but in that case the river is used only as a harbor and its possible development as a navigable waterway for through traffic was not a factor of the problem.

Concrete Fuel-Oil Tank Design and Construction

Precautions To Be Observed in Building Small Oil-Storage Reservoirs for Use in Industrial Plants

FUEL-OIL tanks of concrete became quite common during the war on account of the shortage of steel and the increase in liquid fuel to take the place of the coal which was hard to get. The following paper is an abstract of one on the subject of such tanks read by H. B. Andrews, consulting engineer, of Springfield, Mass., at the recent convention of the American Concrete Institute.

The reservoir should be located a safe distance from inflammable structures as far as possible consistent with pumping requirements, and should be covered with at least 18 in. of earth, if near buildings, to decrease fire hazards and also to minimize oil evaporation. If distant from buildings it should be at least half underground, and, if possible, the excavated material should be used in banking up around it.

The reservoir should be limited in size for two reasons: First, the necessity for not exceeding a day's working limit in operation of pouring concrete so that joints between operations may be eliminated, and second, so that in case of an accident or fire in any reservoir too much oil in storage will not be involved. This size limit should not be over 300,000 gal. under most conditions, and the majority of contractors have not the facilities to construct properly a reservoir of this capacity.

Reservoirs should be circular in shape, the better and more directly to take care of involved stresses and to avert danger of tensile or temperature cracks. They should be so proportioned and designed as to limit the number of pouring operations of concrete, in order to avoid joints between these operations.

Care should be taken to provide for all exterior stresses, such as hydrostatic pressure from groundwater, earth pressure on walls, and roof if reservoir is buried, and also to avoid as far as possible concentration of loads on walls or footings. Where joints are absolutely necessary they should be so protected that there will be no leakage through them. Regarding hydrostatic pressure, while engineers have found from tests that this pressure in soils is only about 50% of the full head of water, it is not safe to design for stresses less than the full head, as any deflection in the concrete admitting a film of water between the earth and the concrete will produce the full hydrostatic pressure.

Concrete surfaces must be temporarily or permanently protected so that oil will not come in immediate contact with them if the concrete is less than six weeks old.

Falsework must be designed to hold concrete temporarily in place so that it will not fail or be distorted while placing concrete. It is especially necessary to provide for the firm holding of wall forms, as the pressure of several feet of concrete poured quickly as a monolith is intense, and any "give" of the forms after the concrete has obtained its initial set breaks up the crystals already formed and allows expansion of the concrete mass, with resultant porosity and loss of strength.

Concrete must be so designed that it will resist all exterior stresses to which it is subjected and so that it will be oil-proof. One of the principal features of this design is to make the walls of circular reservoirs in tension sufficiently thick so that the ultimate strength of the concrete in tension will not be exceeded. It is not meant to leave out the steel reinforcement so that the stress will theoretically be borne by the concrete, but nevertheless it will be borne by it unless some unforeseen weakening of the concrete should throw it upon the steel.

An extended investigation, by the writer, on high circular concrete standpipes for water showed that if the concrete in the wall was stressed beyond its elastic limit, or ultimate strength, which is practically identical, vertical hair cracks will appear of sufficient width to admit water into the body of the concrete.

This ultimate tensile strength in a 1 : 1½ : 3 concrete from tests made for the writer at the Watertown Arsenal was 203 lb. per square inch. Where the concrete is in large sectional areas, and reinforced, this tensile strength will probably be somewhat higher. If a stress not exceeding 150 lb. per square inch is allowed in tension there will be no danger of these vertical cracks appearing.

Reinforcement must be so designed that it will take care of all interior and exterior stresses, and with fittings to hold it rigidly in place while the concrete is being poured. Steel in tension in walls should not be stressed over 10,000 lb. per square inch to conform with insurance company requirements. The writer does not think that it is necessary to figure the stress as low as this, under usual conditions, as he has satisfactorily constructed many reservoirs using a stress of 14,000 lb. But the lower stress is an additional safeguard against inferior workmanship by inexperienced contractors and against any decrease in bond strength due to oil penetration of concrete. It is probably unwise to depart radically from insurance company recommendations.

All reinforcing rods in concrete exposed to oil should be of a deformed section, for better bonding value.

For other parts of the reservoir the recommendations of the Joint Committee on Concrete and Reinforced Concrete should be followed.

The concrete should be no leaner than a mix composed of one part of cement, 1½ parts of sand and three parts broken stone or gravel. To this mix should be added a "densifier." Hydrated lime has been found economical and satisfactory for this purpose, using 10 lb. of dry lime to each bag of cement. The stone must be hard and clean, the best material being traprock, granite or gravel. The sand must be free from any deleterious matter, and should be well graded. Cement should be of an established quality.

The concrete should be deposited continuously in concentric layers not over 12 in. deep in any one place. No break in time over 30 min. is permissible in depositing concrete during any one operation, and if any delay occurs amounting to 30 min. or more the previous surface must be thoroughly chopped up with spades before the next layer of concrete is deposited.

The different operations in pouring are: (1) The pouring of the floor and footings; (2) the pouring of the entire wall; (3) the pouring of the roof. In small reservoirs the wall forms may be supported so that the footings, floor and wall may be poured in one continuous operation. An approved joint or dam must be made between the floor and the wall.

Concrete should be mixed by a mixing plant of sufficient size and power to carry out each separate prearranged operation without danger of delay during the process. The materials should be mixed at least 2 min. in the mixer, using just enough water to obtain a plastic mix without excess water coming to the surface after the concrete is deposited, and a measuring tank should be used so that the amount of water may be kept uniform.

The concrete when deposited in forms should be well spaded by at least four competent laborers who are not afraid to use their muscle in compacting the concrete thoroughly and working out the trapped air bubbles.

Reinforcement should be of round deformed medium steel bars. These bars should be bent or curved true to templets carefully placed in their predesigned location, and rigidly maintained there by mechanical means. No laps should be less than 40 diameters and no two laps of adjacent rods should be directly opposite each other.

The forms should be of a good material, strongly made and so braced, or held in place by circumferential bands, that no distortion allowing displacement of concrete during its initial set is possible.

The surface of the floor should be trowelled smooth as soon as it can be properly done. If all previously named precautions are taken, there should be no defects in the wall to correct.

Concrete designed and placed as recommended herein is practically oil-tight, but as oils are somewhat detrimental to fresh concrete it is advisable to put on an interior wash or coating to protect the fresh concrete from the action of the oil, for such a time as may be necessary for it to cure and harden sufficiently. Silicate of soda, while not a permanent coating, has been used satisfactorily for this purpose according to the following specification for oil-proofing:

"The surface of the floor and the interior surface of the wall are to be coated with silicate of soda of a consistency of 40° Beaumé, and applied as follows:

"*First Coat*—One part of silicate of soda and three parts water, applied with brush, and all excess liquid wiped off with cloth before drying.

"*Second Coat*—One part of silicate of soda and two parts water applied as above.

"*Third Coat*—One part silicate of soda and one part water, applied with brush and allowed to dry.

"*Fourth Coat*—Applied same as third."

Treatment of Boiler Water for Industrial Plants

Coal Economy Demands Scale Prevention—Method Must Be Adapted to the Water—Boiler Compounds Rarely Useful

TREATMENT of feed water for railway and industrial boilers, to prevent the formation of scale, has an important influence upon the efficiency of the boiler and the economy of its service, as is shown in a paper on "Present Tendencies in Water Purification," presented before the Missouri Association of Public Utilities by W. F. Monfort, consulting chemist, St. Louis, Mo. In too many cases steam users use raw water without consideration of its quality, or depend upon certain trade compounds, instead of having analyses made and the treatment problem studied with proper relation to the kind of water that is being used.

It is pointed out that the larger railway systems have found it advantageous to install water-treatment plants. Many industrial enterprises also use softeners regularly, and find economy in installations which take the strain off the boilers, save coal at war prices and maintain expensive plants at high efficiency when labor and material are at a premium, as well as under the old conditions. But a larger number of small and medium-sized water and light plants continue to use water without treatment.

"Recourse to boiler compounds," says Mr. Monfort, "is had sometimes intermittently, quite like that to patent medicines, and there is lack of serious consideration of effects immediately following the use of ill considered compounds devoid of merit. There are few safe remedies which can be applied in boilers. The adequate treatment of a boiler feed water should be based on a complete analysis of the water, should take place outside the boiler and should be tested by its results."

That the analysis should be thorough is indicated by the variety of troubles with feed waters due to silica, sulphates, calcium and magnesium, bicarbonates, sodium and potassium, nitrates, iron, manganese and chlorides. Silica in some waters causes an abundant hard scale. Its treatment calls for special methods. Sulphates in conjunction with calcium yield on evaporation a hard scale of calcium sulphate in some parts of the boiler. The common treatment is addition of soda ash. If this is added to the feed water there may be a high concentration of sodium compounds in the boiler, along with precipitated calcium carbonate, which combination is favorable to wet steam, waste of packing and gaskets, and other ills. Even with pretreatment, foaming may follow.

The treatment must be adapted to the individual supply, which is one reason for its neglect, but at present prices of coal the treatment of feed water is practically an economic necessity. With well supplies of practically constant composition, the maintenance of a softening plant offers little difficulty. With surface supplies, some additional supervision is required, but first cost and operating cost should be more than offset by boiler economies.

Conditions of three kinds of water before and after treatment are shown in the accompanying table. The first was high in calcium and sulphates, forming hard scale, but low in other constituents when treated. With soda ash and lime, the sodium content was increased and foaming resulted. When treated with lime, soda ash and a barium compound, it became a good, soft water, containing little more than 1 lb. of dissolved matter per 1000 gal. and causing neither hard scale nor foaming.

CHARACTER OF RAW AND TREATED WATER FOR BOILERS

	Dissolved Solids		Calcium	Magnesium	Sodium	Bicarbonate	Carbonate	Sulphate	Chloride
1	523	Raw	6.56	2.63	0.02	4.00	0.0	4.38	0.84
	401	Soda lime	1.2	0.1	5.22	0.0	1.3	4.38	8.84
	99	Alternate	1.0	0.0	0.84	0.0	1.0	0.00	0.84
2	162	Raw	3.5	2.9	1.3	7.8	0.0	0.05	0.1
	121	Lime-acid	0.6	0.0	1.3	0.0	0.6	1.20	0.1
3	277	Raw	2.6	1.33	1.56	2.91	0.0	2.16	0.34
	222	Soda-lime	0.9	0.1	2.50	0.0	1.0	2.16	0.34
	158	Alternate	0.9	0.1	1.66	0.0	1.0	1.23	0.34

Calcium and magnesium in waters of high bicarbonate content yield a soft scale, abundant and wasteful of heat. It is difficult to prevent pitting and corrosion of rivets, seams and plates when the deposited soft scale interferes with the quick transmisssion of heat. Great economy results if this scale is precipitated and collected before the feed water is introduced into the boiler. Corrosion is promoted by the deposit of those magnesium salts which decompose with the liberation of acids (magnesium, chloride, sulphate, nitrate) and such excesses of carbonic acid as are frequent in many of our local waters.

Another type of water, common in parts of Illinois, is represented by No. 2 in the accompanying table, which shows the condition before and after treatment with lime and sulphuric acid. The softened water in actual practice is very desirable for boiler use, forming no scale and giving no cause for corrosion. The other water in the table, No. 3, is an average sample from the Missouri River, near its mouth. The results of two kinds of treatment are indicated.

The cost of treatment is given as follows: For water No. 1, soda-lime, 3.42c. per 1000 gal.; alternate, 15.38c.; for No. 2, lime-sulphuric acid, 1.09c.; for No. 3, soda-lime, 0.89c.; alternate, 4.27c. The costs given are based on prices before the war. Present costs are uncertain, says Mr. Monfort, because of the downward tendency which should appear soon. Even allowing for lime at twice the former price, and with soda ash at the double price, and other reagents at current prices, the cost would not be more than doubled. There is still room for economy with the present prices for coal.

Proportion and Reasonable Economy in Rural Road Design

Correct Alignment, Grades, Surfacing, Foundations—Plans for 2000 Miles of Road Reviewed—Recent Practice a Marked Improvement Over Ten Years Ago

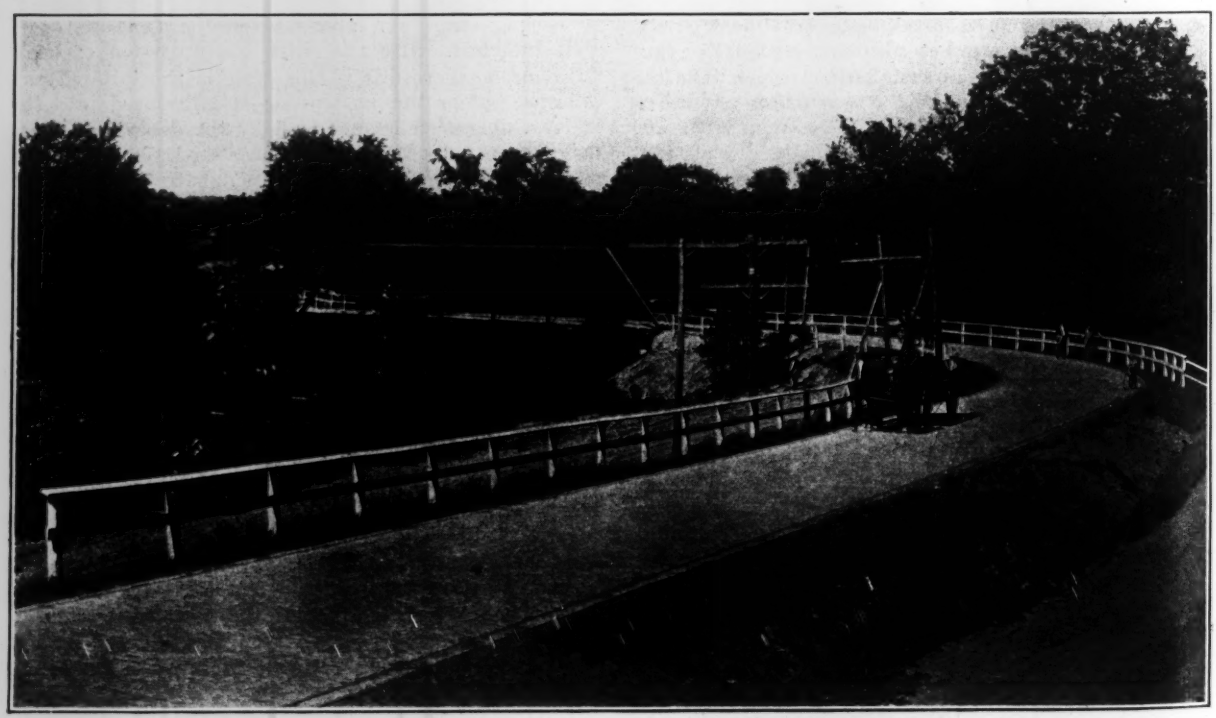
By W. G. Harger
Rochester, N. Y.

PROPORTION and economy in grading, foundations, widths, and courses are discussed in the following article, the data for which have been gathered during the past ten years in connection with the field inspection of improved roads over a rather widely scattered territory, and in the review of plans for some 2000 miles of proposed improvements. The reviews were made in considerable detail by the writer for his own information, with the idea of forming a reasonable conclusion as to the trend of highway design in this country and to see how closely current practice follows the well recognized principles of highway engineering.

The general impression produced was not favorable. The most encouraging feature lay in the fact that the practice of 1918 seemed a marked improvement over that of 1910 in the localities where state and Government aid are becoming active. Some very creditable work is being done, and if this article must deal largely with faults it is not with the intention of discrediting present practice, but rather to point out the lines of further improvement that seem reasonable.

As a rule, the plans and construction subject to local control reflect very closely the general standard of the community in which the work is done; there are some very excellent examples and some crude performances. The various state highway department plans are fairly well standardized, but the design methods are generally too mechanical. The construction cost is often needlessly high (for the results obtained) due to excessive standardization, machine-like design methods and disregard of limited supplies of local materials. The results, as far as actual traffic service is concerned, are usually excellent where enough money is available for the complete and finished design of a reasonable type of road for the existing traffic. Where the funds are inadequate for a completely satisfactory design the results too often show a lack of proportion. The illustration will perhaps show in a general way the point I have in mind. It shows a high-class pavement with dangerous alignment, dangerous section, flimsy guard rail and cheap bridging.

Most roadwork can be classed as a step in progressive improvement; the highway is gradually bettered from a trail to a high-class, modern, heavy-traffic thoroughfare as its use or prospective use warrants the expenditure. In the majority of cases the money at hand is not sufficient for the complete construction of all the features that are desirable even at the time when the improvement is made, and it is never sufficient to build a road that will completely fill the requirements of the future. Some features have to be omitted or slighted. It therefore seems well worth while to encourage first the construction of the fundamental elements which act as a basis for the final improvement, and then in logical order as many of the other desirable parts as can be built. To my mind, the neglect of this principle is the most noticeable fault of present design practice, and the lack of adequate maintenance and renewal provisions the most dangerous feature of present highway programs.



GOOD PAVEMENT WITH POOR ALIGNMENT, BRIDGING AND WIDTH

Road design ranges from the low-type earth roads of sparsely settled districts to the hard-surfaced pavements of densely populated sections. For these extreme conditions the issues are clear-cut; the first required the greatest possible mileage with limited funds, and the last the most suitable design for present conditions regardless of first cost. Intermediate cases are handled by merging the requirements of the extremes. A reasonable design for any case depends on the needs and resources of the local community, considered in connection with the importance of the improvement to the general transportation scheme of the country and the outside aid that will be granted on account of its general importance. In pioneer districts mileage is the only important consideration, and a sufficiently cheap type of construction must be adopted to obtain a line of communication to the point desired; an ordinary earth road is all that can be reasonably expected for the greater part of these districts. Scattered agricultural communities require primarily roads that are usable the year round and that will handle ordinary farm traffic; gravel or similar, fairly cheap constructions are the only reasonable solutions for the greater part of these districts. Densely populated districts with closely located cities require the highest, strongest type of rigid pavements for the main connecting routes and macadam and gravel constructions for the secondary and local roads.

The use of state and national funds is justified for all of these types of construction in their proper places, notwithstanding various resolutions passed by various organizations throughout the country advocating the expenditure of national funds only for the "so-called" permanent types of pavement. The expenditure of such funds is justified anywhere so long as their use actually improves fundamental road conditions. It is not justified for roads that are allowed to "go to pot" through inadequate maintenance—which is happening to most of our roads at the present time; it is not justified when applied to high-type pavements on excessive grades; it is not justified on roads whose usefulness is handicapped by weak bridges; it is not justified on isolated "pork barrel" improvements; and certainly it is not justified on extremely expensive, extra-wide roads of limited length suitable for the next generation, when the main need of this country is mileage of roads suitable for present conditions.

If this is so, it certainly pays to construct what is done so that it can be readily strengthened and widened as the future requires, without losing the benefit of previous work. The following tentative list illustrates an order of importance of design elements which probably applies to most cases, with some minor variations:

Design Features

First, selection of the best general route.
- (a) Best location for the development of the territory.
- (b) Longest open season.
- (c) Least rise and fall.
- (d) Length and cost.

Second, selection of the most natural engineering location following the desired general route.
- (a) Reasonable grades.
- (b) Exposure. Avoid north exposure and areas of deep snow.
- (c) Character of excavation. Avoid rock, slides, etc.
- (d) Drainage problems. Avoid flood areas, stream crossings, etc.
- (e) Avoid artificial restrictions such as section line locations, etc.

Third, detail requirements of design.
- (a) Reasonable maximum grade, considering future requirements.
- (b) Economical intermediate grades.
- (c) Safe and economical alignment, considering future requirements.
- (d) Width of roadway safe for traffic, eliminating dangerous ditches.
- (e) Width of roadway convenient for traffic.
- (f) Sufficient culverts and bridges to protect the roadway, considering the future.
- (g) Permanent construction of these culverts and bridges.
- (h) Sufficient width of clearing for sun to reach road.
- (i) Safety provisions. Protection for traffic at dangerous places.
- (j) Provision of liberal width of right-of-way, considering future widenings and development.

Fourth, improvement of the road surface.
- (a) By selective soil treatment.
- (b) By gravel, chert, etc.
- (c) By rigid pavements.

Fifth, improvements for the future.
- (a) A higher-grade surface.
- (b) A wider hard surface.
- (c) Provision of sidewalks for pedestrians.
- (d) Planting trees, etc.

An examination of the roads in almost any locality leaves the impression that a little more emphasis on and attention to the better construction of the fundamental features will add to the reasonable proportion of design and be a move in the right direction.

Reasonable Economy in Design

The mileage to be constructed in the near future is so great and the amount of money involved so impressive that it seems desirable to use all possible care to produce as many miles of road as can be done with the available funds. The results of the analysis of the road plans mentioned in the opening paragraph were, roughly, as follows: About 25% could be classed as first-class designs from an economical standpoint. Practically all the designs showed minor wastes, but for the plans classed as good, revisions would not result in any practical advantage. About 75% of the plans showed a material expenditure of money for which no adequate return was obtained, amounting to from 5% to 20% of the cost. On some of the roads which, as built, served the traffic well, this excess might better have been spent on other jobs. On some of the roads which, as built, were not up to the requirements of the traffic, the waste might better have been applied to their own improvement in fundamental features.

The general faults most noticeable were:

Too much spent on the reduction of intermediate grades.
Too much spent to obtain long straight grades.
Too much spent on sections with deep ditches.
Not enough spent on realignment at dangerous locations.
Not enough spent on long-span bridges.
Too much spent on width of macadam.
Not enough spent on depth of macadam.
Too much spent on imported materials where local materials were available in limited quantities.

An article of this nature cannot go into much detail as to the exact methods, but a summary can be given of a few of the well recognized, proved means of effecting economies without reducing the usefulness of the road. The probable savings from these expedients as given below are based on the experience of the writer and

his friends from their application on construction jobs for a number of years. The original plans on which the construction revisions were made were well up to the standard of the usual highway plan of today.

GRADING ECONOMIES

Use of the "rolling" grade line for intermediate grades.

Avoid long, straight, railroad rates of grade.

Avoid the reduction of easy grades naturally less than the improved ruling grade.

Avoid long, needlessly high bridge-approach fills level with high bridge floors.

Utilize the principle of the short maximum grade in connection with a long ruling grade.

Use of the minimum-width grading section with the shallowest ditches that will serve the purpose.

Use of a reasonable ratio of cut to fill, so that excavation is not wasted.

Balance with short hauls wherever possible.

These principles consistently applied have reduced the yardage of excavation by from 500 to 2500 cu.yd. per mile, the average saving amounting in money to about $500 to $600 per mile on the basis of excavation at 50c. per cubic yard. I have one extreme case in mind where excavation was reduced 30%; the original hauls were long wagon hauls; the final grade line reduced the work to such short hauls that it could be handled largely with wheeled scrapers and road machines; this materially cheapened the unit cost, which happened to be force account, and the quantity reduction plus the unit cost reduction reduced the total grading cost about 50 per cent.

Economies in Macadam Foundations—There is no economy in using a depth less than that required by the traffic and soil requirements. The following table indicates the depths that seem necessary for different conditions, as determined by the action of well built macadam roads in New York State subjected to modern traffic. It will be noted that the depths are greater than ordinarily used.

TOTAL CONSOLIDATED DEPTHS OF MACADAM

Subgrade Soil	Cut, Inches	Shallow Fills Less Than 1 Ft. Deep, Inches	Intermediate Fills 1 to 3 Ft. Deep Inches	High Fills Above 3 Ft. Deep Inches
Class I Traffic				
Large volume of ordinary vehicles and heavy auto trucks				
Coarse sand and fine gravel..	9	9	9	9
Clay loam.....	12 to 15	12 to 15	10 to 12	10
Heavy clay and quicksand..	20 to 24	20 to 24	12 to 18	10
Class II Traffic				
Large volume ordinary traffic. A few heavy trucks				
Sand and gravel.....	7 to 8	7 to 8	7 to 8	7 to 8
Loam.....	9 to 12	9 to 12	9	8
Clay and quicksand.....	15 to 22	15 to 22	12 to 15	9
Class III Traffic				
Moderate volume ordinary farm loads. Very few heavy trucks				
Sand and gravel.....	5 to 8	5 to 8	5 to 8	5 to 8
Loam.....	8 to 12	8 to 12	8	7 to 8
Clay and quicksand.....	15 to 22	15 to 22	10 to 15	9

Note.—Under Class III traffic it is better to use the same depth as recommended for Class II and reduce the width of metaling if economy is desired, as all improved roads are bound at times to be subjected to the extreme loading produced by heavy trucks.

Economical foundation design utilizes to the best advantage all local material, preferably uncrushed, to its full extent. Uniform designs that disregard limited amounts of suitable local materials often increase the cost from $500 to $1000 per mile.

Economies in Pavement Widths—In the writer's opinion, a 14-ft. width is more or less useless; it might better be cut to a 12- or even a 10-ft. or increased to 15 ft.; if the cut is feasible it saves on macadam construction from $1000 to $2000 per mile; similarly, a 16-ft. width might better be cut to 15 ft. or increased to 18 ft.; if the cut is feasible it saves from $600 to $700 per mile. No rigid pavements are advocated less than 18 ft. wide.

Economies in Top Courses—Where imported materials are used, the least depth of top that is feasible is often good practice. This applies to the smaller paving brick, stone block, vitrified clay cubes and the 2½-in. depth of penetration bituminous macadam, etc., which often save from $400 to $1000 per mile.

Total Saving—None of these economies is spectacular singly or for one job, but if consistently used the result is well worth the effort, considering the tremendous mileage to be built. A very conservative estimate of the average saving is from $1000 to $2000 per mile. Multiply this out and see what it means. Two features that are most worth emphasizing are the grading design and the effective use of limited supplies of local materials.

A Reviewing Department Well Worth While—The writer believes that every set of plans should be subjected to the review of the most experienced designer available, who applies a set of questions, say, as follows:

QUESTIONNAIRE

Is the alignment suitable for all requirements of the future?

Is the ruling grade suitable for all requirements of the future?

Is the section, ditch to ditch, safe and suitable for present traffic?

Is the right-of-way wide enough for future requirements?

Are there ample culverts for all requirements of the future?

Are the culverts proportioned properly as to size? considering run-off?

Are the culverts long enough to be safe and large enough to maintain?

Are the bridge superstructures strong enough for present traffic?

Have all permanent culverts and bridges been designed strong enough and wide enough for, say, 50 years?

Are the bridge abutments for new temporary superstructures solid enough for future permanent superstructures?

Are the ditches road ditches and not farm drainage ditches?

Are the safety provisions real safeguards or are they only warnings?

Is the road surface thick enough to handle present traffic without foundation failure, considering the subsoil conditions?

Is the road surface wide enough for present traffic and can it be widened to meet the demands of, say, 50 years without regrading the section?

Is the surface of the general type required by present traffic?

So Much for Proportion—Now for Economy:

Does the grade line conform with the principles of economical design?

Do the sections fluctuate to conform to economical design?

Has the selection of pavement type been based on the most economical use of local materials?

Has the design been varied to use limited supplies of local material with short hauls?

Is the width reasonable, and has it been varied on a road that has heavy traffic part of the distance and light traffic part of the way?

Has the depth of macadam been varied to meet the different requirements of the soils and kept to a reasonable minimum?

Have the culverts and bridges been designed for the most economical type for the span in question?

Have the types of culverts been varied to get the cheapest

SUMMARY SHOWING APPROXIMATE YEARLY COST PER MILE OF DIFFERENT KINDS OF ROADS

Type of Pavement	Width and Thickness Including Base: Width Feet	Thickness Inches	Class of Traffic	First Cost per Mile, Including Grading, Pavement, Drainage and All Incidentals	Four per Cent. Yearly Interest on First Cost	Approx. Yearly Maintenance, Including Oiling	Cost of Resurfacing, Distributed Over Probable Life: Assumed Length of Life Years	Cost of Resurfacing, Distributed Over Probable Life: of Road on Yearly Basis	Total Cost per Mile per Year
Stone block	18	13	I	$36,000	$1,440	$150	35	$700	$2,300
Asphalt block	18	9	I	28,000	1,120	150	25	800	2,100
Asphaltic concrete	18	8	I-IV	22,000	880	300	10	1,200	2,400
Brick	18	10	I	26,000	1,040	150	15	1,100	2,300
First-class cement concrete	18	8	I	20,000	800	150	12	1,100	2,050
First-class cement concrete	18	7	IIA-IV	18,000	720	100	15	800	1,600
Bituminous macadam	15	12	II-IIA-IV	14,000	560	350	10	550	1,450
Water macadam tarred	15	12	II	12,000	480	450	7	500	1,450
Water macadam oiled or treated with calcium chloride	14	9	III	9,000	360	350	10	400	1,110
Water macadam calcium and oiled	10	10	III	8,000	320	350	10	350	1,000
First-class cement concrete	10	6	III	12,000	480	200	15	550	1,250

NOTE.—It can be seen that our experience indicates that the selection of type has very little effect on final cost and that for.
Class I Traffic (interest, maintenance and renewal is approximately $2200 per mile per year).
Class II Traffic (interest, maintenance and renewal is approximately $1600 per mile per year).
Class III Traffic (interest, maintenance and renewal is approximately $1100 per mile per year).

result, considering local materials, in comparison with market quotations and cost of long hauls on imported materials?

Are the specifications flexible enough to permit the reasonable use of local materials?

Does the testing laboratory make an effort to approve the reasonable use of local material, or is it inclined to hold arbitrarily to the highest standards, regardless of the relative importance of the job in hand?

So Much for the Designer—Now for a Few Questions to the State Highway Commissioner:

Does the improvement fit into a well balanced scheme of highway transportation for the state? (This can probably be answered in the affirmative.)

Is there sufficient provision made for maintaining and renewing the pavement on this road, as indicated in a general way in the accompanying tables?

It is not probable that the funds will be forthcoming until a number of roads in each locality have been ruined by neglect. This is the most forceful way of bringing the matter home, but rather expensive. It seems well worth while to do a little more talking and advertising—perhaps by public speakers, popular magazines, the "movies," etc., about the real cost of maintaining and renewing an improved road system. Public officials naturally hesitate to ask for what they know is necessary, unless the real need of these large amounts is recognized in the proper quarters and tolerated by the voters.

APPROXIMATE YEARLY COST OF EARTH AND SAND-CLAY AND GRAVEL ROADS

Type	Approx. Cost per Mile	Four per Cent. Interest on First Cost	Approx. Yearly Maintenance and Renewal	Total Yearly Cost per Mile
Earth	$2,000	$80	$50	$130
Sand-clay	3,000	120	75	200
Gravel	4,000	160	240	400

The present tendency is to build high-priced pavements which require very little maintenance for a number of years; this relieves the immediate stress but cuts down needed mileage and merely postpones the day of reckoning. Take any set of plans that is handy and try out these questions. If more than 25% pass more than 75% of the list, you are among the leaders in highway design.

Oil Shale Resources of the United States

An investigation of the oil-shale resources of the United States is provided for in a bill introduced recently by Senator Henderson of Nevada. The bill carries an appropriation of $140,000 and specifies that the work is to be done by the Bureau of Mines.

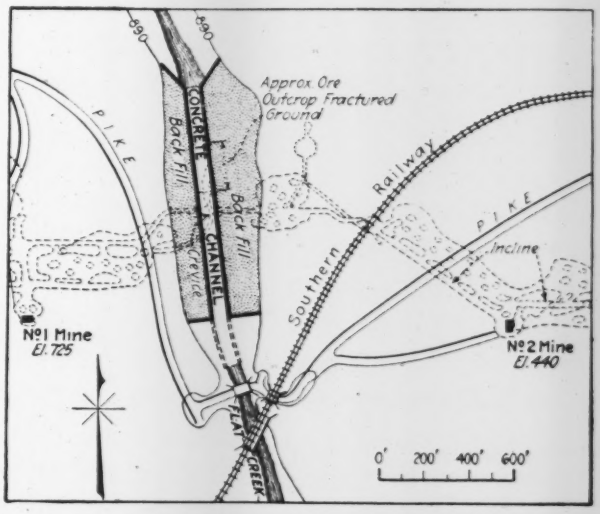
Concrete Channel for Stream Over Fractured Mine Outcrop

Flood Water Which Formerly Backed Up Creek and Seeped Through Into Mine Below Is Now Carried Past Broken Ground

BY HARLEY A. COY
Superintendent of Mines, American Zinc Co. of Tennessee, Mascot, Tenn.

FLOODS due to the penetration of river water through broken ground at the ore outcrop caused an enormous amount of trouble in the mines of the American Zinc Co. of Tennessee at Mascot, Tenn., some years ago. The difficulty has now been removed by the construction of a concrete channel to carry the creek across the fractured area.

Flat Creek, shown in the map herewith, is a very small stream flowing south about halfway between No. 1 and No. 2 shafts of the mine and passing over the outcrop of the ore body. In the earlier workings of the mine the water from the creek during high stages gave some trouble, which was taken care of by diverting the flow of water into a lower, worked-out portion of the mine, but as No. 1 workings advanced east additional crevices and openings were encountered, and each year, when floods occurred in the Holston River, into



CONCRETE CHANNEL PREVENTS CREEK WATER FROM FILTERING INTO MINE WORKINGS

LOOKING UPSTREAM AT CONCRETE CHANNEL BUILT TO CARRY FLAT CREEK OVER ZINC MINES

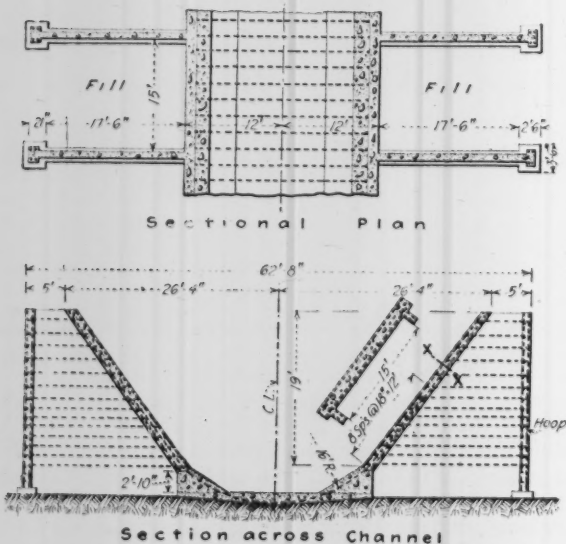
which Flat Creek empties about 2800 ft. below the mine outcrop, the water backed up the creek and, filtering through the surface cracks, kept entering the mine in increasing quantity.

In January, 1916, the first high water from the river found its way into No. 1 mine through various crevices and completely filled it, reaching a height of 125 ft. above the main level. As near as it could be figured, the volume of water was over 90,000,000 gal. Special pumps were installed and the mine was emptied, but after this experience it was decided that something radical had to be done in the over-mine area. At first some steps were taken to concrete a number of crevices. The formation along the outcrop was found to be so broken that it seemed impossible to fill in with concrete all of the openings, so this work was discontinued. Various schemes considering the diversion of the creek were studied, but were abandoned, and finally the concrete channel shown herewith was built.

The structure comprises a trough-shaped reinforced-concrete channel about 1000 ft. long, supported at the invert on a solid, continuous bottom footing on the rock and held on the side by concrete-wall buttresses spaced 15 ft. c. to c. The area back of the channel proper was filled in up to the level of the top of the channel with slime from the nearby flotation mill. At either end of the structure, wing walls continue back to the fill contour so as to prevent water from getting into any of the fractured area.

When this channel was built originally it was the intention to extend it about 200 ft. further south than the present south wing wall, and the invert of the channel was built as shown in the view. Before the completion of the work it was found unnecessary to extend the high portion so far beyond the outcrop, so the wing walls were extended to the bank, as shown in the drawing and views. The bottom of the concrete channel is approximately 150 ft. above that portion of the mine directly under the channel, but there are places on either side where the mine workings are within 75 ft. of the bottom of the channel.

There have been two floods since the work was completed. Both of them reached a higher stage than any before noted, but there has been only very slight increase in the flow of water underground during the flood stage.



DETAILS OF THE CONCRETE CHANNEL CARRYING CREEK OVER MINE WORKINGS

Wagon Gages and Street-Railway Gages

Wagon wheel-gages are governed by the gage of street-railway track, according to R. C. Cram, of the Brooklyn Rapid Transit Co., in "Notes on the History and Development of Electric Railway Rails," in the *Electric Railway Journal* of July 19, 1919. In speaking of the modifications in rail section made to improve paving conditions and reduce the rut formation produced by heavy wagon traffic, Mr. Cram says: "Wagon makers are wiseacres. Originally, it is believed, the rail gage was made the standard gage of 4 ft. 8½ in. because it was wagon gage also, and wagons were first used on rails. However that may be, the writer has observed that in cities where the gage of the tracks is 5 ft. 2 in. the wagon gage is the same, and that in all cities the wagons generally will readily follow in the tracks whatever the gage may be."

Rondout Creek Bridge Design Condemned for Excessive Load on Batter Piles

State Highway Commissioner Considers Pier Foundation Dangerous and Superstructure Design Not Adapted to Site—Plan Supported by Engineers of Former Administration

SUBSTRUCTURE work for a large highway bridge over Rondout Creek, at Kingston, N. Y., was stopped recently by order of the new State Highway Commissioner, Frederick Stuart Greene. Commissioner Greene had occasion to examine the plans for the structure shortly after taking up the duties of the office; he concluded that the proposed foundation for the main pier was unsafe, and therefore canceled the contract. He found, furthermore, that in the opinion of several contractors the superstructure could not be built for the available money, and as he also considered the design unsuited to the location he withdrew the superstructure from bidding Apr. 22, two days before bids were to be opened. Work is now under way on the preparation of new designs, the bridge being required as part of the new state highway from Kingston to Port Ewen, a link in the main New York-Albany highway along the west bank of the Hudson River.

The crossing is about a mile from the mouth of the creek, where the valley is about 1200 ft. wide. At the sides of the valley, rock is near the surface, but in the middle it is at considerable depth. War Department requirements with respect to navigation, fixing a clearance height of 85 ft. on a width of 200 ft. over Rondout Creek, governed the design of the bridge.

Fig. 1 herewith gives an outline drawing of the condemned design. It was prepared under the supervision of the preceding administration of the Highway Department by William R. Davis, consulting engineer, of Albany, N. Y. The main part of the structure consists of two steel arch spans of 360 ft., with a rise of 110 ft. The piers carrying these arches are solid only up to the springing line, and above this are broken up into separate shafts to secure lightness without sacrificing architectural effect. The center pier rests on a pile foundation, the piles going 60 ft. below water. This foundation was the main object of criticism on the part of Commissioner Greene.

As shown by Fig. 2 (see illustration on next page), the foundation piles are driven inclined on a 1:5 batter, alternately a pile-row in one direction and a row in the other, with a view to giving stability against any unbalanced thrust developed by the two arches, whether due to live loads or to deck-renewal work or the like. On either side are two rows of vertical piles, but these are only a minor element of the foundation; of the 390 piles in the whole foundation, 338 are batter piles and 52 are plumb piles. The bearing-pile cluster is surrounded by an inclosing wall of concrete sheet piles, intended to serve as cofferdam during construction and subsequently as a bearing element for the outer part of the capping slab. This inclosure consists of individual piles 12 x 24 in. in section and 25 ft. long, with embedded metal interlock sections. A reinforced-concrete capping slab 13 ft. thick, 60 x 87 ft. in area, extends over the whole group of piles.

The foundation was to carry a gross load, dead plus live, of something over 9000 tons. Commissioner Greene considered that this would put a dangerously high load on the piles. He states his attitude as follows:

> After I had looked over the plans of the bridge as formerly designed, and especially noted the load that the piles were asked to carry, I did not consider the foundation safe. Upon inquiry as to why these piles were loaded so heavily, I was informed that they expected the reinforced-concrete cofferdam to take part of the load. As this cofferdam did not go down to the underlying strata of sand and boulders, but, in a way of speaking, was "hung up" in the filled ground, I did not and do not consider that it would have been safe to have figured on this cofferdam carrying any part of the load. I at once referred the matter to Daniel E. Moran, consulting engineer, New York City, who confirmed my opinion, and, as I did not purpose either to begin or end my administration by putting up a structure which I considered unsafe, I withdrew the bridge from the letting.
>
> As originally designed, this bridge consisted of two huge steel arches, the shore ends of each resting upon rock, but the center main foundation pier was designed as a pile foundation. The design was not, in my opinion, good in any respect, nor did it fit the ground.

Some additional facts are contained in the following passages of a statement from the Commissioner to the Governor:

> Upon taking office I was informed by my predecessor

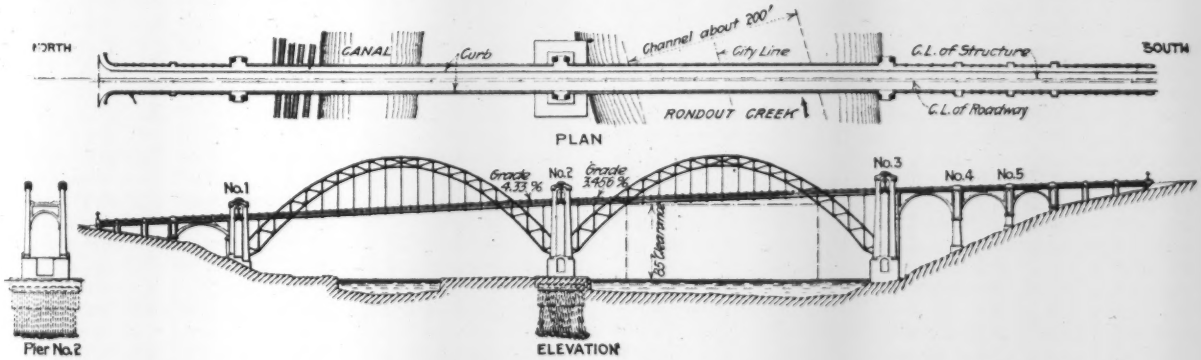


FIG. 1. RONDOUT CREEK BRIDGE DESIGN WHICH WAS RECENTLY ABANDONED; CENTER PIER FOUNDATION COMPOSED OF BATTER PILES CAPPED WITH REINFORCED-CONCRETE SLABS

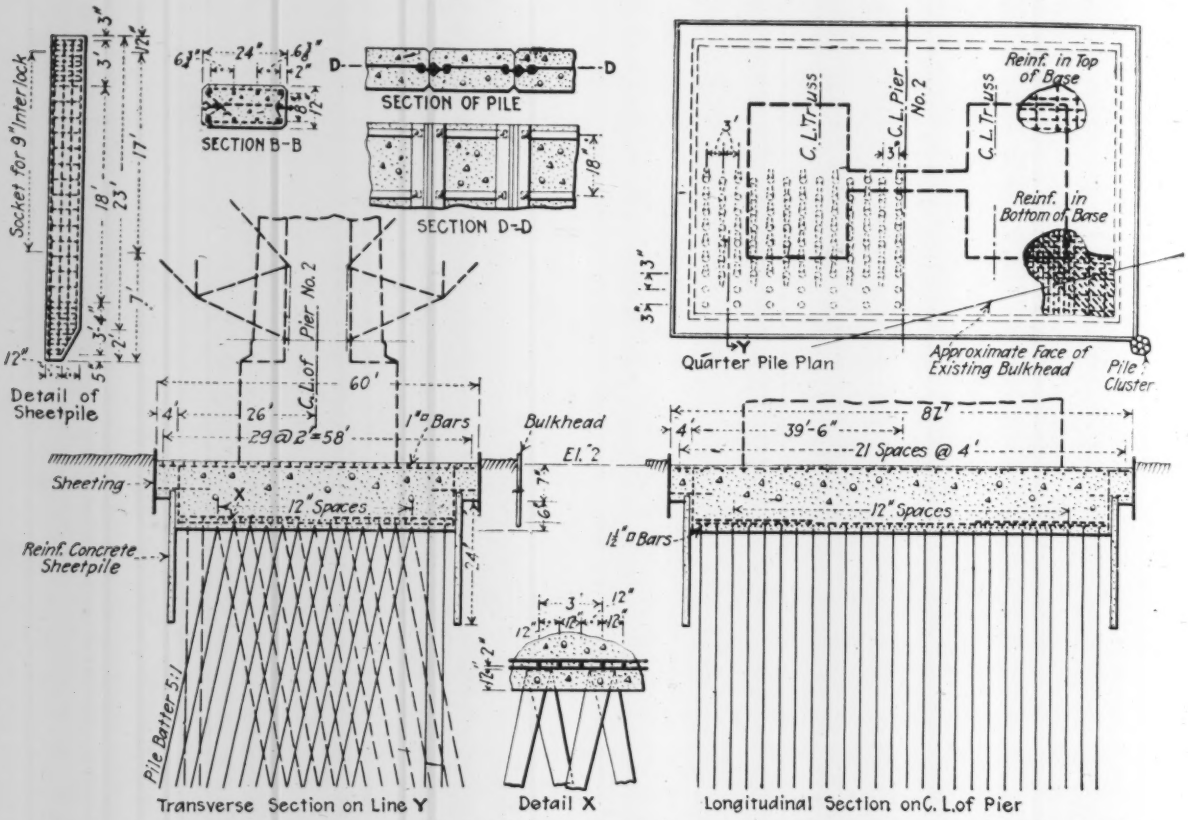


FIG. 2. DETAILS OF BATTER-PILE FOUNDATION OF CENTER PIER; CONCRETE SHEET-PILE COFFERDAM TO REMAIN AS PERMANENT INCLOSURE WALL OF FOUNDATION SOIL

that this bridge was an important project, and my attention was called to the early date that proposals were to be received. I at once sent for the plans, and upon my first examination of them was surprised to find that the piles for the main foundation were designed to be driven at an angle. To drive bearing piles off the perpendicular was in my opinion bad in theory, and so far as I know has never been done. The innovation seemed so far from sound engineering principles that I decided to make a thorough study of the plans. I found that these wooden piles, supporting the foundation upon which depended the safety of the entire bridge, were to carry a load of 25½ tons each. This was an alarming discovery. The foundation was located upon made ground, in what had once been the center of the stream, and the piles were driven through this filled-in material to an under stratum of sand and boulders. Under the conditions, I considered that a load of more than 15 tons per pile was dangerous. Realizing the state's responsibility in the construction of this important bridge, I sought the most expert advice that the engineering profession has to offer and withdrew the bridge from the letting.

After a further study of the plans, I became convinced that the bridge could not have been built within the engineer's estimate of $321,000, and several contractors who figured the job have informed us that the bridge, as designed, would have cost between $450,000 and $475,000. Aside from the faulty foundation, I have found other defects in design, which in my opinion would make it unwise, not to say unsafe, to construct the bridge as formerly planned.

I regret to inform you that part of the foundation work, let under a previous contract, has been done, and that the money so spent has been wasted. Through this faulty design the state has suffered a financial loss of $47,916.40. [Of this, $37,500.97 represents payments to contractors.—EDITOR].

It is my purpose to redesign this bridge; in fact, new plans are now under way, and the bridge will be constructed as speedily as possible, consistent with safety and good workmanship. In order to safeguard the state's interests I have retained Mr. Moran as engineer for the new designs. Mr. Moran has already submitted preliminary sketches of a bridge which will not only give us a safe structure, but one that will be a pride to the entire state. His plan, which is a massive concrete viaduct, with a concrete arch over the canal, and a steel truss spanning the stream, admirably fits the ground, and will be less expensive to construct and maintain than a bridge built after the former design, even had that design been safe. The former design called for two steel arches each 360 ft. long. To keep these arches in condition would have required repainting about every three years, which on arches of this length and height would have been a continual and heavy maintenance charge for the state to meet.

A sketch of the design now under consideration by the State Highway Department is reproduced as Fig. 3 herewith. A steel arch truss over the river is shown in the sketch, but in the final development of the design a truss of ordinary type may possibly be substituted. The crossing over the canal is made by a large concrete arch, and the rest of the structure is concrete arch viaduct.

Study of the site has led to the conclusion that it may be economy to use the concrete pier already completed on the south side of the creek. At present it is thought probable that this will be done.

Replying to Mr. Greene's strictures on the design and the work done on the foundations, statements have been made at the request of *Engineering News-Record* by

H. Eltinge Breed, deputy commissioner of highways under the last administration, and by W. R. Davis, designer of the bridge. Mr. Breed says:

The location of the bridge had already been decided by the Carlisle administration. We examined and approved it because it provided the quickest and most dignified entrance into the town, eliminated steep grades, was economical and met the situation from the engineering standpoint. It gave general satisfaction to the people of the city and the vicinity who were most familiar with the need of the bridge. We sought to secure the best possible design, both in strength and beauty, by calling to our assistance an expert in bridge construction. We asked William Russell Davis to design the bridge, because we considered that his training, experience and successful previous work peculiarly qualified him for the task.

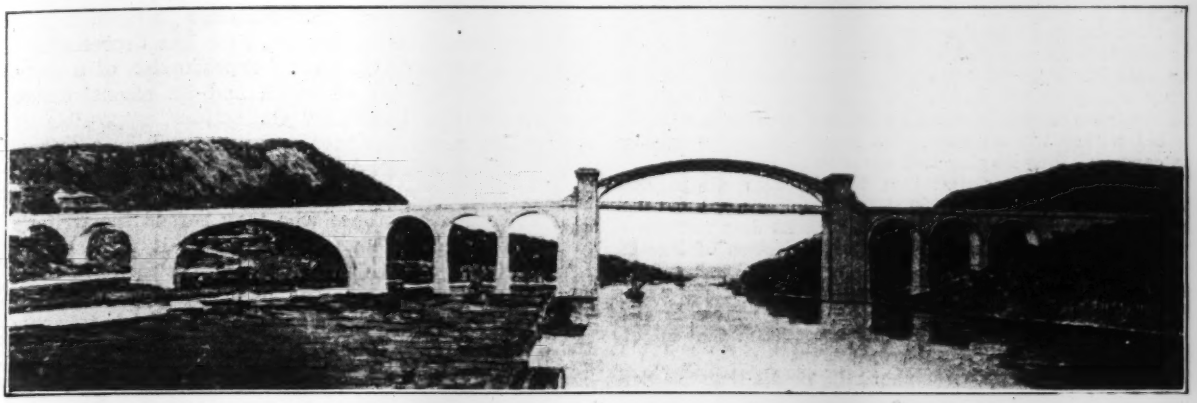


FIG. 3. STUDY FOR NEW DESIGN, RONDOUT CREEK BRIDGE, KINGSTON, N. Y.

Mr. Davis has designed and built bridges for 25 years. Not one of his structures has ever failed. As bridge engineer of the City of New York he designed and constructed the 151st St. viaduct and the Melrose Ave. viaduct. For 13 years he was chief bridge designer to the State Engineer and designed work amounting to $5,000,000. In his private practice he has designed the dock, bridge, and siphon spillway for the General Electric Co. of Schenectady. We have the highest regard for Mr. Davis as an engineer and a bridge expert, and we have every confidence in his design. Such objections as Mr. Greene makes do not seem to us valid in view of the obvious facts; he fails to sustain his assertion that the design does not "fit the ground."

Actual construction work, until the time it was stopped, progressed smoothly with every indication of complete success. About one-third of the piles were driven, a No. 2 steam hammer, weighing about 5500 lb., being used. The piles were driven until they brought up hard, the penetration for the last 20 blows being ¼ in. or less, and the entire penetration being such as to show no pockets of soft material. There was, and is, no doubt in our minds that the bridge was thoroughly adequate in design and construction to the loading it would be required to sustain. Anyone, however, who had wanted additional factors of safety could have secured them at comparatively slight increase of cost by spreading the foundation and driving additional piles. I can see no reason from an engineering standpoint for abandoning the entire project, or for the so-called "waste" of the $47,916.40.

The pier design is discussed in some detail by Mr. Davis, the author of the original design, who says:

It is contended by Commissioner Greene that each of the 390 bearing piles is loaded with 25½ tons, which, if his method of estimating is accepted, is approximately correct. In other words, the total weight at the top of the bearing piles, with total weight of sheet piles included, is nearly 9900 tons. In these figures no allowance is made for the fact that the bottom of the concrete foundation is 4.8 ft. below lowest low water as shown by the records of the United States Engineer Department.

The upward pressure of water to be properly deducted is 300 lb. per square foot, or a total of 616 tons. The weight of sheet piles (480 tons) should not be included. Thus, the total load per pile, if no allowance is made for the supporting resistance of the sheet piles or for the sand inclosed within the sheeting, is close to 22½ tons instead of 25½ tons, as claimed.

It is known that the reinforced-concrete sheet piling drove hard and that it has definite supporting power. It is also proper practice to allow the materials in which the piles are driven to carry some load when properly confined within a suitable inclosure. Such an inclosure was provided with tops of all sheet piles securely tied to the concrete foundation. Deducting the supporting power of 390 piles at 16 tons each leaves 2564 tons to be carried on the sand around the piles. The net area is 3718 sq.ft., giving 0.7 tons per square foot, which is to be considered satisfactory when allowance is made for the supporting power of the sheet piles.

The bridge which carries the West Shore R.R. over Rondout Creek, a short distance above the site of Pier 2, is founded in like materials and subject to like conditions, except as to live-load impacts, which are much greater for a railroad bridge than for a highway bridge. The load on the piles under certain of the piers for the West Shore bridge is 20 tons per pile, and these piles have proven satisfactory over a long term of service. There is no question but that properly driven piles under Pier 2 can be safely loaded to 20 tons.

I quote from Commissioner Greene as follows: "To drive bearing piles off the perpendicular was, in my opinion, bad in theory and, so far as I know never has been done." It is well established that batter piles can be properly driven if suitable driving equipment is used by competent men, and that, if the batter does not exceed that used for Pier 2, the supporting power is substantially as great as for vertical piles. Batter piles have been successfully driven and relied upon to take the thrust on abutments of simple-span bridges, arches and elsewhere, and have proven to be dependable. That an arrangement of such piles which is possibly new was used for Pier 1 is not valid criticism. It is the duty of the engineer to use new arrangements of tried materials when good reasons warrant. The use of batter piles is so well established that it is not necessary to take space to cite examples.

Pier 2 supports two 360-ft. three-hinged arches. In order to take care of the possible unbalanced loads, it was thought best to drive about one-half of the piles with a batter in one direction and about one-half with a batter in the other direction. All engineers will readily understand how, with the top of each pile securely embedded in the concrete of the foundation, by resolution of forces the unbalanced hori-

zontal forces will positively transmit a certain proportion of the vertical loads from one set of batter piles to the other set without producing bending of piles or dependence upon other resistance to motion.

The division engineer in charge of construction was thoroughly familiar with the design, and would most certainly have reported the facts had it been discovered during construction that the plans were based on misinformation or wrong assumptions as to foundation conditions. No such report was ever made, and hence the writer is justified in contending that no good reason exists for condemning the design, which he is confident is entirely adequate.

It is stated by Commissioner Greene that in his opinion the bridge could not have been completed according to the design of the writer within the amount of money available. The Commissioner's predecessor in office had advertised for bids and it is known that at least several bids would have been submitted had Commissioner Greene not canceled the letting a day or two before the date set. The writer is of the opinion that there would probably have been at least one bid within the estimate. He regrets that the letting was canceled, thus leaving this question in doubt.

The Commissioner claims that the defective design has caused a loss of nearly $50,000 to the state. He has thrown away one pier foundation on rock which he does not criticise. If he is not satisfied with the foundation of Pier 2 and wishes to reduce the pile loads, which the writer considers unnecessary, the footings can be extended and additional piles driven as provided for by the writer in the specifications to cover any unforeseen condition that might arise.

In conclusion, the writer emphatically denies that the pier in question was not properly designed. From the information at hand he finds no justification for the condemnation of the pier or the abandonment of the entire design, for the choice of a new location or for the waste of moneys already expended.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Valuations for Rate Regulation

Sir—Just now would seem to be the time to stop, look and listen in the matter of valuations for rate regulation.

The more or less time-honored custom of valuing utility properties on the basis of cost of reproduction less depreciation, with prices as of the present time or even with prices averaged over a very few years last past, would seem to be likely to bring utilities into trouble at a later date. Assuming that there is to be a material drop in prices—possibly even a panic bringing a very large drop—and at any rate some drop, what is going to happen to the utility that is valued now on the basis of high prices and capitalizes that value, and is forced to reduce its rates within the next few years because of a lower valuation put upon it? If it be argued that capitalization will not follow a high valuation because of the high rates to be paid for money, is not this argument an admission that the valuation is too high?

Does not the situation at the present time, with the reasonable prospect ahead, add much of force to the argument that was presented by the writer in *Engineering News-Record* of Sept. 5, 1918, p. 451, to make cost of service the chief factor in rate regulation?

If, in a valuation of a growing property, the estimate of the physical items is based on the actual sacrifice to produce them—including, as it must, sacrifices at comparatively recent high rates—and if cost of operation, including maintenance, is estimated at prevailing prices and a proper profit is allowed on such cost of operation, it would seem that the utility would get all that it may be entitled to, and will not be put in the dangerous position of imagining that it has a large value which it can capitalize—only to find a part of that value destroyed within the next few years as prices drop.

Are not those on the defensive who have interpreted "present value" in the court decisions to mean cost of reproduction as of the present time less depreciation? That real monstrosity, cost of reproduction of a property, the wiping out of which and its reconstruction are both purely imaginary conceptions, impossible of realization, never has been and never will be a correct basis for the value of a long-lived public-utility property.

It is hoped that those who may reread the writer's article mentioned above, or may read it for the first time, will see by the application of the methods there suggested a way out of the present difficulties. Certainly, these are dangerous times in which to apply the theory of cost of reproduction at present prices less depreciation, in the valuation of a public-utility property—dangerous more to the utility itself than to the public concerned.

The language of the court in that old decision saying "fair return on the fair value of the property used in service" may voice a correct principle, but it seems to be almost certain that it has been productive of much difficulty, much greater than would have been caused by the establishment of another principle apparently equally sound—namely, a utility owner is entitled to a fair profit on the reasonable cost of the service rendered.

WILLIAM G. RAYMOND,
Dean, College of Applied Science, State University of Iowa.
Iowa City, Iowa.

Transit or Plane-Table for Topography

Sir—After several months of plane-table work, I can quite agree with Hargraves Wood of Martinsburg, W. Va., in his belief that the plane-table is superior to the transit for topographical surveying. [See *Engineering News-Record* of July 10, 1919, p. 95.]

In the first place, topographical surveying is the object of the plane-table and, consequently, it has been perfected to a high degree of accuracy for that purpose, while the transit has an unlimited number of uses of which topographical surveying is a side issue. With the plane-table you have the drawing paper and topography directly before you, and as a result can draw it just as it is. This cannot be done with a transit.

Contours can be chased and located exactly, provided the Beamen-arc style of alidade is used in the plane-table work. The old style alidade with a vertical-angle arc is far inferior to the Beamen arc, which enables the recorder to compute his notes while the instrument man is locating his next sight. The vertical angle on the transit requires a tabulated set of tables for the computations, which is not the case with the Beamen-arc alidade.

For orientation, the backsight and foresight method

of traversing is exceedingly accurate, as is the use of the magnetic needle, if it is well taken care of and damage is prevented. Orientation by the use of flags which were previously located by triangulation and plotted on the paper by coördinants is also very accurate, and most errors can be picked up by solving a three-point problem, which is not as difficult as some imagine.

The Gurley alidade of the Beamen-arc style was used exclusively by the 472nd Engineers, U. S. A., in their work of mapping a section of Virginia and the District of Columbia, to say nothing of the 180-square mile reservation at Fort Sill, Okla., prior to the contemplated shipment overseas of the Engineers.

The United States Geological Survey engineers assert that the plane-table is much more rapid than the transit in topographical surveying, fully as accurate as the result can be plotted, regardless of scale, far easier than the laborious transit method, and much more complete in its work. When you come in at night after using a plane-table with Beamen-arc alidade, the notes are all computed, the plotting is completed and a large area of ground has been covered, while with the transit method notes must be computed and the map plotted in the office, the latter map lacking the finer details obtained only when using a plane-table.

In my estimation it is a one-sided argument in favor of the plane-table to contrast the two methods of taking topography.

FRED VERNON.

Schenectady, N. Y.

Sir—In your journal for July 10, 1919, p. 95, the question of the plane-table versus the transit for topographical surveys is brought up by Hargraves Wood.

From considerable experience in the past in this line of work, I have come to the conclusion that each method has its particular sphere of usefulness.

The plane-table is particularly adapted to an open country, where considerable detail is desired on a map of fairly large scale, such as for parks, cemeteries and private estates. But it is cumbersome to carry about, and where large areas are to be covered, especially in hilly and wooded territory and where contours are not closer than 10-ft. intervals, the use of the transit with vertical arc and stadia and a small plotting table, as devised and used by Dr. Rudolph Hering in surveys for the water department, Philadelphia, in 1883-1886 (see *Engineering News* of Sept. 26, 1885, p. 302) is believed to be far superior. This system was also used with some modifications in a survey of the Connellsville coke region made by me in 1890-1892 (see *Engineering News* of Nov. 7, 1891, p. 446) and was found admirably adapted to the conditions there, being rapid, reliable and economical. The results of both of the surveys referred to have been incorporated in the standard United States Geological Survey sheets for the respective territories.

New York City. KENNETH ALLEN.

Sir—*Engineering News-Record* of July 10, 1919, p. 95, contained a letter from H. Wood raising the question why the plane-table was not used in taking topography for railroad location surveys. Since 1917 the subject of railroad location has been quite out of date. But as there is promise, in some quarters, of a revival of the art, a few remarks may not be out of place at this time.

Mr. Wood answers his own question when he states that considerable experience is needed to operate a plane-table efficiently. That is perhaps the reason why one never sees a plane-table in a railroad survey party—not that the railroads lack efficient men, but their work is not continuous enough to develop instrument men with sufficient experience to run a plane-table efficiently. It is more nearly the rule than the reverse, that railroad location parties are organized hurriedly for a limited amount of work. New men must be broken in to take topography, and naturally they must be taught the simplest methods first. This results in the method by transit lines, with cross-sections at more or less frequent intervals. Often quite ingenious methods are used, but the plane-table is conspicuous by its absence.

The writer would advocate keeping one plane-table in the equipment of every railroad survey party, and one man fully able to run it. The plane-table could be used in taking topography from the preliminary line. The existing practice of first running a preliminary line need not be abandoned in favor of plane-table work. Railroad surveys cover a comparatively long and narrow strip of ground, and the accuracy needed even for a "preliminary" line could not be secured with plane-table without a greater expense than the common method of running preliminary line. Also, there would be trouble in staking out a projected location from a map which contained no preliminary lines from which to make ties.

However, a plane-table will give accuracy greater than that obtained by common methods; its cost is less, its speed is greater, and it would prove invaluable for the many little odd jobs of any survey requiring detail, natural or artificial. The only objection which could be raised against it is the fact that plane-table work must be done on small sheets, and the work transferred to the larger map. But this objection is not valid, as the same thing applies to any method where contours are sketched in the field.

For transferring topography, taken on small sheets to a larger map, the writer prefers to trace the work directly by means of home-made copying paper, made by ordinary scratch paper and soft lead pencil. Marks made on a map from this kind of paper can be easily erased, which cannot be said of ordinary typewriting paper or carbon paper.

F. J. HOWES,
Resident Engineer, Northern Pacific Railway Co.

Emigrant, Mont.

Concrete for Railway Track Support

Sir—Referring to an article entitled "Concrete for Railway Track Support," in *Engineering News-Record* of July 24, 1919, p. 165: While the concrete slabs supporting the tracks of the Northern Pacific Ry. in the State of Washington are the most extensive use of this construction on main line, I beg to call your attention to a paper prepared by the writer entitled "Concrete Railway Track Support," which was read before the American Concrete Institute June 28, 1919, wherein were shown a considerable number of other examples of concrete slabs supporting railway track.

The article in the July 24 issue of *Engineering News-Record* says that this example of the Northern Pacific Ry. is the only example of such construction on the

open line You are doubtless aware that the Pennsylvania Railroad Terminal in New York City has more than 14,000 ft. of slab concrete under its tracks and that 720 ft. of similar construction is in use near East River tunnels Nos. 1 and 2, where it is subjected to high-speed traffic.

There is on the Chicago Junction Ry. in Chicago approximately 500 ft. of solid concrete track support that has been in use since 1911. This stretch of track was selected purposely so as to subject it to the heaviest traffic conditions of any track on the Chicago Junction Ry. A majority of the stock trains going to the Chicago stockyards pass over this experimental track. The service derived from it, according to G. W. Hegel, chief engineer of the Chicago Junction Ry., has been entirely satisfactory.

You may not call these examples open-line service, but they do represent the two extremes of such service: namely, high-speed passenger traffic and comparatively low-speed heavy-freight traffic.

A. C. IRWIN,
Engineer, Structural Bureau, Portland Cement Association.
Chicago, Ill.

Further Criticism of Fineness-Modulus and Surface-Area Methods

Sir—The replies of Professor Abrams in *Engineering News-Record* of June 12, 1919, p. 1142, and Mr. Edwards in the issue of July 24, 1919, p. 191, to our article, "Tests of Two Recent Theories for Proportioning Concrete," published in the issue of June 12, 1919, p. 1142, seem to us to evade direct and definite reference to the fundamental errors in the two theories which it was the purpose of our article to point out. It is true that our criticism was more destructive than constructive, but justifiable on the ground that engineers and others, who are not in a position to test fully the new theories, may not be misled by faulty or incomplete evidence.

We have at this time no new theory of proportioning concrete to present. Any such offering should be thoroughly tested under all practical conditions with the widest variations in aggregates found in practice, and its limitations should be clearly known before offering it to the public.

We believe, however, that our article has constructive value in calling attention to the necessity for some adequate means of controlling the water content of concrete mixtures, which Professor Abrams himself regards as the most potent of the ingredients. In his laboratory work, however, Professor Abrams has thrown aside the all-important water control to such an extent that the concretes given in Table 2 of the above bulletin, which are said to have constant consistencies, really vary more than 25% in this respect; that is, the amount of water in the wettest of these mixes is more than 25% greater than that required to yield the consistency of the driest of these mixes.

The following is a reply to the detailed criticisms of our previous article, and statements of definite reasons for the failure of both theories are included.

The wide variations in grading of aggregates in our Tables I to III were included to show the effect of any additions of aggregate to a neat cement paste. It is well known that ordinary concrete is weaker than the aggregate of which it is composed, and that a concrete is also weaker than a neat cement paste which has the same consistency or flowability. For the sake of economy it is necessary to sacrifice strength, with the result that ordinary good-quality concretes have a fraction of the strengh of either the cement or the aggregate particles. To emphasize that the resulting function of any added aggregate is to lower strength, these series were included. It should be pointed out that if many of these mortars and concretes had been made so as to have equal flowability or consistency instead of equal water-cement ratios, much lower strengths would have been obtained, as compared with a neat cement paste of the same consistency. To pass over a series of tests with the statement that the aggregates are of freak gradings emphasizes the fact that "freak" gradings in one locality may be quite similar in many respects to aggregates in common use in another, and that an arbitrary decision as to "freakishness" does not alter the fact that something is wrong with any theory which ceases to function within any limits which may be encountered in practice, or which do not include concretes of better quality than that of the ordinary structural type. Even though the aggregate gradings for the ones which have been termed freakish are not those commonly met with, the mass is in all cases composed of similar particles which have the same compositions and physical characteristics as those aggregates labeled normal, and so long as they can be formed into a plastic, workable combination, the same laws, if correct, must govern them.

The following comments refer more specifically to the criticisms offered by Mr. Edwards:

Whether or not the area of large particles in a concrete mix is considered in proportioning the quantity of cement is of little moment, since the surface area of coarse aggregate per unit weight is only a fraction of that found for the same weight of sand. The aggregates included in our Table V all passed the ¾-in. screen, so they may be classed as sands. The area of the particles, per 100 grams retained on the No. 4 sieve in the case of aggregate 57, is 35 sq.in., and the total for the aggregate per 100 grams is 568 sq.in., so that the area of the portion above the usual sand size is negligible.

Mr. Edwards states that " . . . . the surface-area method is not comparable with the methods used in the tests described in Tables II, III, IV and VI," of our article. That these tables of results are of direct bearing upon the accuracy of the surface-area theory is shown by the following quotation from Mr. Edwards' article in the American Society for Testing Materials "Proceedings," Vol. XVIII, 1918, p. 235:

> The results obtained show that the strengths of mortars of uniform consistency containing sand aggregates of varying granulometric composition are directly proportional to the quantity of cement they contain in relation to the surface area of the aggregate.

With regard to our italicized statement that "the surface-area method after fixing a ratio of cement to surface area of aggregate arrives at the same final conclusion," etc., this is an accurate statement of fact verified by the mathematical demonstration which follows it, and by Table VII in Mr. Edwards' 1918 A. S. T. M. paper, p. 256. This table includes nine aggregates in the first group, all of which have the constant water-cement volume ratio (Abrams w/c), of

0.426, and also a constant ratio of water to cement by weight of 0.284, or 28.4 per cent.

Further reference to this table indicates that the proportions of cement to aggregate by weight varied from 1: 1.12 to 1: 3.11, and yet it is stated that this water formula which results in the constant w/c relation of 0.426 gives mortars of the same consistency. The absurdity of such a statement should require no proof to anyone who is familiar with testing of concrete. This table alone disproves the claims made for the surface-area method. In practice, lean mixes require a higher value of w/c than rich mixes for the same consistency or flowability, yet here it is stated that a 1: 1.12 proportion had the same consistency as a 1: 3.11 proportion.

We have checked the consistencies by duplicating the mortars made up of his aggregates C, E, and G, as specified in this table. We are at a loss to explain how anyone can put forth such data with the claim that equal consistencies or flows were obtained under the conditions. We found the water formula and the quantities of mixing water specified by Mr. Edwards to be entirely inadequate, thereby bearing out the statement in our June 12 article in which we showed that the formula would supply 7.42% for a 1: 3 standard sand mixture, whereas the 10.3% called for in standard specifications is actually too little to furnish a good, working, plastic mix. *Not only did the formula supply too little water for all of the above three aggregates, but there was a wide difference in consistency very apparent to the eye and verified by the flow test.*

The tests on the Edwards aggregates E, C, and G may be summarized as follows:

MIXING WATER

	Specified by Edwards formula w/c constant		As used in our tests w/c constant			As used to obtain equal flows			
*	cc	w/c	cc	w/c	Relative Flow	cc	w/c	Relative flow	†
E	553	0.426	720	0.555	170	720	0.555	170	3855
C	343	0.426	447	0.555	125	497	0.616	168	3170
G	178	0.426	234	0.555	No flow not plastic	342	0.820	171	1810

* Aggregate
† Compressive Strength, Lb. per Sq.In., Age 7 Days

The above data show: (1) The water formula is inadequate to give good, working, plastic mixes; (2) with ratio of cement to surface area fixed it gives a constant water-cement ratio for all mortars; (3) instead of mortars of the same consistency, mortars of widely varying consistency result. Instead of constant w/c values which, it is claimed, give uniform flows, the water-cement ratios varied from 0.555 to 0.820.

We believe that the data given in Mr. Edwards' Table VII, together with the above, effectually disprove the claims made for the surface-area method of proportioning mortar and concrete.

The following refers more specifically to Professor Abrams' criticisms:

In reply to the statement that some of the mortars of Table II were too dry, we would state that these mixtures were all plastic, and that well formed test specimens were made in the usual manner. The seven-day strength results also indicate good quality mortar.

He states that aggregate 62 makes up the only normal mortar shown in the group (Table II) with constant w/c, and that the others are too dry. It is difficult to follow this reasoning, since the addition of more water resulted in lower strengths. It would be just as logical to state that the first group is too strong as well as too dry. It is not claimed that the w/c constant group had equal flows, but all were plastic and easily molded.

The aggregates used in the concretes of Table IV are criticized as being too coarse, probably due to the low strength results obtained in some cases with a constant w/c.

These low strengths are not due to coarseness, but to adherence to the Abrams water formula, which provides too much mixing water for coarse aggregates, resulting in concretes having unequal flows which are not comparable. It should be noted that these poor aggregates 2, 3, 7, and 8, when tested with flow constant, showed good strength increases which indicated them to be among the best aggregates in the group. It would seem that any standard of coarseness which would rule out such aggregates must be seriously in error. Aggregates 7 and 8 are criticised as being decidedly freakish in that all material is retained on the 28- or 48-mesh sieves. This same criticism can equally well be made of the Abrams aggregates 271 and 276, Table II, Lewis Institute Bulletin No. 1. However, tests show that all four of these aggregates are satisfactory from the standpoint of workability and compressive strength, when proper account is taken of flowability.

With respect to our Table VI, which is made up of aggregates included in the above Lewis Institute Bulletin, we feel that Professor Abrams has evaded the real issue, which is the lack of uniformity in workability found when concretes are proportioned by the fineness-modulus theory. We pointed out in text and diagram the wide range of workabilities found for his aggregates which, he states, results in concretes of the *same consistency*. As for the surface-area theory, the water formula which is supposed to give any desired workability or consistency for known conditions of cement and aggregate fails to function, and this failure, which disproves the fundamental and necessary assumption of the fineness-modulus theory, is not touched upon by its author in his discussion of our results.

The expression for quantity of mixing water is as follows:

$$x = R\left[3/2\,p + \left(\frac{0.30}{1.26^m} + a - c\right)n\right]$$

It is stated that with m, fineness modulus, and n, proportion of cement to aggregate, constant, the same consistency will result, and the same strength will be obtained whatever the grading of the aggregate within rather wide limits.

As shown in Table 2, Lewis Institute Bulletin No. 1, with m constant there may be wide differences in grading with large differences in surface areas. For the aggregates shown in this table, the surfaces vary approximately 600%. It has been well established in concreting practice that for the same consistency a fine sand requires more mixing water than a coarse sand, that a sand similar to a beach sand requires more than a coarse, graded concrete sand, and that sands commonly used throughout the country may vary over several hundred per cent. in surface area.

In spite of this well understood condition, that a fine sand, one having a large surface area, will require more water than a coarser sand, it is claimed that the above water formula will result in the same consist-

ency for any group of aggregates having the other conditions constant. Although not expressed in so many words, *the Abrams water formula is equivalent to the statement that whatever the gradation, sands having the same fineness modulus, although varying as much as 600% in surface area, require the same quantity of mixing water for the same consistency.* That this is untrue is shown by the variation in the surface areas of the aggregates in his Table 2, all of which have the same fineness modulus, 6.04. The falsity of the water formula is further proved by the flowability tests which we made on eight of these aggregates and included in our Table VI, as well as the results of the previously quoted tests in which the Edwards aggregates C, E, and G were used.

To obtain constant flow among any such group of aggregates, it is necessary to vary the quantity of water for each, and as soon as this is done the constant water-cement ratio, the foundation upon which the fineness-modulus theory has been built, disappears.

Summarizing, both the surface-area theory and the fineness-modulus theory assume that known and equal consistencies can be obtained by the use of the water formulas which each provides, but both fail to accomplish this in practice.

It has been shown that the surface-area theory formula reduces to the constant w/c relation for any fixed relation of cement to surface area of aggregate, and that the important property of surface area does not enter into the determination of the quantity of mixing water, except in so far as it fixes the quantity of cement at the beginning. The formula is not only incorrect in theory, but is inadequate in practice, and results in mortars and concretes varying widely in workability which are in no sense comparable. That this is strictly true is proved by the data given in the proponent's own article, in the A. S. T. M. "Proceedings" for 1918.

The fineness theory assumes that equal consistencies and strengths are obtained by the use of a water formula which disregards the varying water requirements due to differences in number of particles or surface area of aggregate. Any factor which might be added to take account of this variable condition will result in different values of w/c for each aggregate, thereby losing the constant w/c relation which is claimed to be the criterion for equal strengths. The wide variations in gradations of aggregates given with the author's description of the theory disprove the assumption that any given consistency can be obtained for a group of aggregates by the use of his water formula.

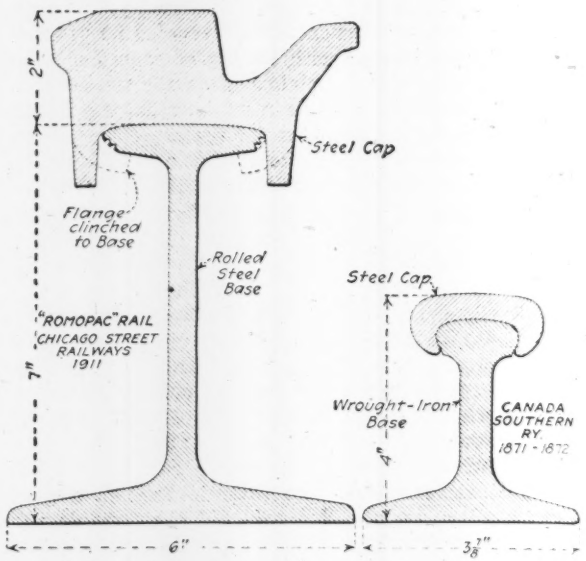
The test data which he includes clearly indicate that the fineness-modulus method of proportioning fails in practice.

No doubt, continued experiments by all interested in the testing of concretes and concrete materials will finally lead to some method which will aid in the proportioning of any given material to produce a concrete of known quality, but we cannot see how the above theories as now proposed are in any sense a final solution of the problem.

G. M. WILLIAMS,
WATSON DAVIS,
United States Bureau of Standards.
Washington, D. C.

Compound Rails With Separate Heads

Sir—I have noticed recently in *Engineering News-Record* sketches of several unusual old and odd rail sections. Inclosed is a tracing showing a "steel-cap" rail at one time in use on the St. Clair branch of the



TWO TYPES OF OLD COMPOUND RAILS

Canada Southern Ry. This rail consists of a wrought-iron base and web with a steel top. It was laid about 1871 or 1872 and failed after only a few years' use.

Bay City, Mich. S. D. WILLIAMS, JR.
Division Engineer, Michigan Central Railroad.

[Presumably the cap of this rail was rolled in place upon the bulb head, but with the rail-mill machinery of those days it is not likely that the contact surfaces were regular or that the grip of the cap was very secure. About 1906 a development of this idea was tried on the street railways of Leeds, England, and the Chicago street railways experimented with it in 1911. We have reproduced this section beside the Canada Southern rail. In this case the cap formed a grooved head and was of channel section. It was applied by means of a powerful bending machine which clinched the flanges of the channel under the bulb head of the base section. A curious feature was that the cap was applied after the substructure of the track had been completed, the clinching or crimping being done by a machine traveling on the track. For renewal, the same machine could cut and split off one flange, so that the cap could be removed. The cap and base were laid to break joint.

Some trouble with proper adjustment of the cap was experienced on the Chicago work, but was attributed to failure to roll the cap to the exact section desired. It was said that no such trouble was experienced on the English work. The system was not developed on a commercial basis in this country, however. For those who may wish to look up its records, we give the following references to articles in *Engineering News*: 1906, May 26, p. 571; 1911, Sept. 28, pp. 374 and 386; 1912, Feb. 1, p. 216, and Nov. 28, p. 1007; 1913, Jan. 23, p. 179, and March 13, p. 527.—EDITOR.]

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Improvised Hoisting Derrick Tilts Steel Stack Onto Base

A HOISTING rig improvised from spare timbers and two chain-blocks successfully up-ended a steel stack, approximately 75 ft. high and weighing 70 tons, for the copper-smelting works at Benson, Ariz. The operations and the equipment are indicated by the diagrams. Two timbers were fixed for deadmen, and two others, one on each side of the old concrete base, were placed as sills for the A-frame.

The feet of the A-frame were hinged to the sills by cutting slots in them. Strap-iron loops on the feet of the A-frame extending down into these slots with iron pins passing through timbers and loops, and into the concrete base for anchorage, completed the construction equipment.

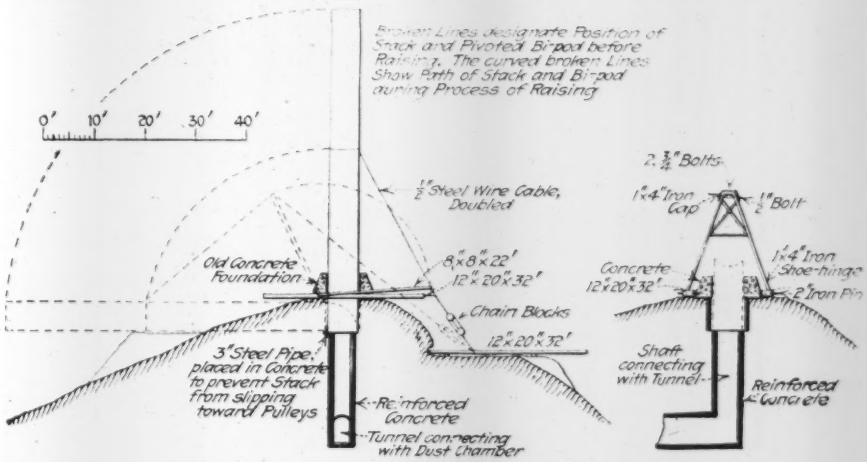
The chain-blocks were rigged to separate hitches so that one would hold the stack while the cables were being shortened on the other. The length of pull of the blocks was about 10 ft., and four changes of cable were necessary to up-end the stack. When pulling was commenced at a flat angle the stack was given a start with screw jacks, but afterward the two chain-blocks handled the stack readily.

The cost of the operation was $316 for labor and $54 for material. This description has been prepared from an article by Martin Fishback in *Engineering & Mining Journal* of July 19, 1919.

Other Articles in This Issue of Interest to Contractors:

New Construction Methods in Subway Work Under Philadelphia City Hall — Page 300

Electricity Cuts Construction-Plant Power Costs — Page 311

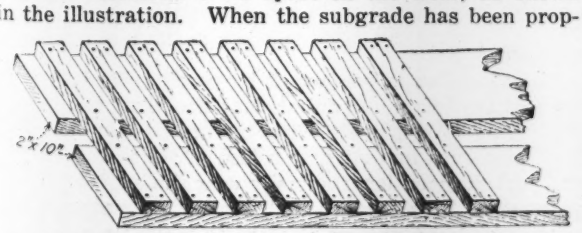

Broken Lines designate Position of Stack and Pivoted Bi-pod before Raising. The curved broken Lines show Path of Stack and Bi-pod during Process of Raising
0' 10' 20' 30' 40'
1/2" Steel Wire Cable, Doubled
Old Concrete Foundation
8"x8"x22'
12"x20"x32'
Chain Blocks
12"x20"x32'
3" Steel Pipe placed in Concrete to prevent Stack from slipping toward Pulleys
Reinforced Concrete
Tunnel connecting with Dust Chamber
2 3/4" Bolts
1"x4" Iron Cap
1/2" Bolt
Concrete 12"x20"x32'
1"x4" Iron Shoe-hinge
2" Iron Pin
Shaft connecting with Tunnel
Reinforced Concrete

HOISTING RIG FOR UP-ENDING STEEL STACK

Motor-Truck Boardwalks for Muddy or Sandy Soil

A DEVICE that is being used in southern New Jersey to facilitate the operation of motor trucks is a boardwalk. On one contract 1500 feet of this boardwalk was in use recently to pass motor trucks over sandy soil or muddy subgrades.

The tracks are composed of two 2 x 10-in. 16-ft. planks, set 24 in. out to out and tied together with 2 x 4-in. material 3 in. apart in the clear, as shown in the illustration. When the subgrade has been properly crowned and graded, and it is not desired to cut it up with motor trucks, these boardwalks are laid lengthwise of the grade and at the proper gage. The spaces between the cross-treads not only give good traction but allow the trucks to proceed up the grade for distance equal to the length of the tracks, without injury to the grading. The tracks were in use on the work of H. Wilhelm Sons for the New Jersey State Highway Department, W. G. Thompson, state highway engineer.



DETAILS OF BOARDWALK FOR MOTOR TRUCKS

Six-Inch Steam Pipe Replaces Wood Rolls Under Dragline Excavator

BY G. E. WRIGHT
Bridgeport, Conn.

THE use of wooden rollers under a Bucyrus dragline excavator weighing about 60 tons caused considerable trouble and some delay, by the splitting or crushing of the rolls. It was decided to try 6-in. steam-pipe to replace the broken rolls. This worked so well that the wooden rolls were discarded altogether. The pipes were of such length that a man could handle them and pass them ahead. Three or four rolls were used under each of the four skids.

The work was being done on tidal flats, where the tide left the machine alternately high and dry and standing in 5 to 7 ft. of water. It was working on the

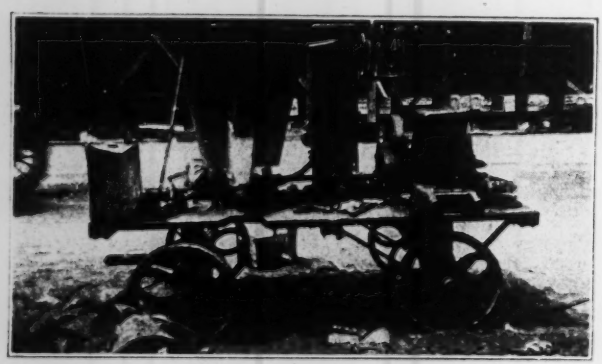
STEAM PIPE REPLACES WOODEN ROLLERS

seawall extension being constructed by the T. A. Scott Co., of New London, Conn., for the City of Bridgeport, Conn., making a fill back of the wall. The material was dipped directly from the sand flats in front of the wall by the machine, which was carried on wooden mats and hauled ahead by dipping the bucket in the sand and hauling in on the dragline. It was equipped with a bucket of two-yard capacity.

C. A. Calahan was superintendent for the contractor. A. H. Terry was consulting engineer for the city and J. A. McElroy is city engineer. The writer was engineer in charge of construction.

Handy Mechanical Device for Mixing Mastic Pavement Filler

MASTIC filler for granite-block pavement is being successfully mixed by a small mechanical device on contract work in New York City. Numerous hand mixing methods have been employed for this material, but it is difficult to obtain the proper agitation and thorough mixing which can be accomplished by mechanical means. The small mechanical plant shown in the view is giving a very thorough mix.



OUTFIT FOR MIXING HOT MASTIC FILLER FOR BLOCK PAVEMENTS

The device consists of an inverted conical drum which has paddles working on the inside through the cogs shown at the base. Power is furnished by a 10-hp. gasoline engine, while a hand pump is used to transfer the liquid bituminous material from the heating tank to the drum. The pump, shown between the engine and the drum, is arranged so that the correct amount of bituminous material is transferred at each pumping. The apparatus works with either tar or asphalt mastic. In the particular case illustrated asphalt mastic is being mixed.

When the device is operating, the bituminous material is first pumped into the drum, and then the proper amount of thoroughly dried sand is thrown in and agitated, until an even mixture is obtained. This is then allowed to flow out at the opening at the bottom, into wheelbarrows, from which it is dumped upon the pavement and squeegeed into the joints. The mixture is about 1 of sand to 1 of bituminous cement.

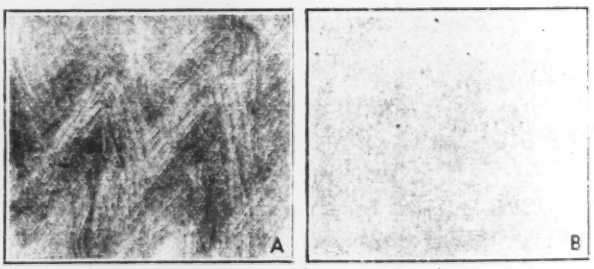
The work is being done, under the supervision of Robert MacGregor, assistant engineer of the Department of Public Works of the Borough of Manhattan, by the W. J. Fitzgerald Co., of New York City. M. H. Lynch is engineer for the contractor. It is stated that the complete outfit costs about $500.

FILLING GRANITE BLOCK WITH ASPHALT MASTIC

Removing Diamond-Shaped Serrations From Belt-Finished Concrete Roads

WHEN a concrete road is finished by the belt method, diamond-shaped serrations are left as the belt travels crosswise of the road and slides lengthwise at the same time. These are due to movement of the larger particles of the sand grains.

While the serrations do not affect the life of the pavement, they give it a sort of wavy appearance, which is undesirable. This has been overcome in New Jersey by a method proposed by W. G. Thompson, state highway engineer, and the result is shown in the accompany illustration. A shows the straight belt-finished road, while B shows the surface after the serrations are removed.



SURFACE OF CONCRETE ROAD BEFORE AND AFTER FINAL BELTING

The operation is performed by passing the belt over the surface twice. The first time the usual method of zigzagging is employed, while the second time the belt is carried back and slightly raised at the forward edge and just dragged longitudinally over the surface of the pavement. This covers up all the zigzag marks in the surface and the process appears to make no new ones longitudinally.

NEWS OF THE WEEK

New York, August 14, 1919

War Labor Board Ends Existence

The National War Labor Board ended its existence Aug. 12, through announcement of the oint chairmen, William H. Taft and Basil M. Manly, issued after a meeting of that board in New York City which adopted resolutions to the effect that no new cases would be received.

The War Labor Board was created by an act of the President early in 1918. It was said that, though he had created the board, the President had no hand in the termination of its existence. The expenses of the board were paid out of a war emergency appropriation, and it was said that its end was brought about "more through lack of funds than anything else."

During the 15 months of its existence the board has handled and adjusted more than 1,200 labor disputes and has expended $750,000. In every case brought before it labor benefited by increased wages.

Another East River Tunnel Holed Through

Excavation work in the north tube of the 14th St. rapid-transit tunnel under the East River, New York City, was completed Aug. 7, when the last piece of rock between the tunnel headings between Brooklyn and Manhattan was shot away. The river section of the tunnel is 3437 ft. between shafts. The top of the tunnel is 97 ft. below mean high water at the lowest point, while the bottom is 115 ft. The maximum pressure used in driving the tunnel was 39 lb. The termini of the tunnel are East 14th St., Manhattan, and the foot of North 7th St., Williamsburg, Brooklyn.

One Hundred Engineers for Civilian Service

About 100 engineers will be released from Government service in the Western district, Interstate Commerce Commission, on or about Oct. 1. These men have been employed by the Government at salaries ranging from $725 to $3000 per annum, plus all expenses. Many of them have had extensive experience in the construction and maintenance of railways, and in general engineering.

John S. Worley, member of the Engineering Board, with headquarters at Interstate Building, Kansas City, Mo., will be glad to correspond with anyone with reference to the employment of any of these men. If interested persons will write to him the particular employment for which services are sought, and the range of salaries, he will be glad to give a complete statement of any one of the men whom he would recommend.

It is thought this may be of considerable interest to many of the readers of *Engineering News-Record*.

Employment Bureaus

Engineering Societies' Employment Bureau of the four founder societies, conducted by Engineering Council Employment service, for members and for other professional men introduced by members. Especial attention for those released from Government service. Address, 29 W. 39th St., New York City.

American Association of Engineers, 29 S. La Salle St., Chicago. Service to members only, but Army or Navy Engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

Professional and Special Section, United States Employment Service, 469 Fifth Ave., New York City.

Reëmployment Committee of New York City for Soldiers, Sailors and Marines, 505 Pearl St.

Carnegie Dies in 84th Year

Andrew Carnegie died at his summer home in Lenox, Mass., Aug. 11, in his 84th year. He entered the steel business in 1863, having previously come to this country from Scotland, and having become a telegraph messenger at 14. He became a telegraph operator for the Pennsylvania R.R. and subsequently was made division superintendent. It is estimated that his fortune approximates $500,000,000.

Zoning for Washington, D. C.

A zoning commission for the District of Columbia is proposed by Senate bill 1369, introduced by Senator Calder of New York. The commission would be composed of the three commissioners of the District of Columbia, the officer in charge of public buildings and grounds of the District and the superintendent of the United States Capitol building and grounds. Within six months of the passage of the act the commission would divide the District of Columbia into height, area and use districts. The bill has the approval of the District commissioners.

Policies Stated by Highways Transport Committee

Rail and Water Facilities Declared Important — Effect of Transport on Public Health—Membership

At a recent meeting of the Highways Transport Committee, as newly organized, a policy was stated regarding the various means of transportation, such as rail, both steam and electric, and water. The effect of highway transport on the public health, as set forth by medical journals, was also made a matter of record. Emphasis was placed upon the necessity for developing highway transport to the utmost, and consideration was given to making such operation safer both as an investment and physically.

In stating its peace-time policy, the committee declared for greater highway transportation facilities to increase production and aid in distribution. However, it questions the value of such transportation when established parallel to and in direct competition with rail and water facilities. Rail and water transport should be fostered, and, at the same time, as stated in resolutions adopted, "the committee is becoming more and more convinced that the development of efficient rail, electric and water facilities is dependent upon the establishment of highway transportation facilities in territories such as will prove complementary to such rail, electric and waterways systems, instead of competing with them."

Good Roads and Health

In further advocacy of highway transport, an editorial published in *Modern Medicine*, entitled "Good Roads and Health," was introduced into the minutes of the meeting. This editorial set forth that rural health conditions, especially among babies and mothers, and contrary to general belief, are lower than city health conditions. This was attributed to poor highway facilities which hinder physicians. The proportion of young men unfit for service in the war was as great in country as in city districts, it was stated.

The committee is anxious to learn of locations where proper facilities are lacking, with a view to organizing rural motor-express routes, and return-load bureaus, which are necessary to make the routes a paying investment. The necessity of improving the locations of roads at corners, etc., to make them safer, was also emphasized by a report taken from the *Commercial Motor* of England. This extract advocated that powers be given to the proper authorities to regulate the clearances and

visibility at corners, by removing hedges, buildings and high fences.

The Highways Transport Committee as now constituted consists of the following representatives of Government departments:

War Department, Lieut. Col. J. M. Ritchie, Motor Transport Corps; Post-office Department, James I. Blakslee, fourth assistant postmaster general; Interior Department, John W. Halowell, assistant to the secretary; Department of Agriculture, James H. Collins, of the Bureau of Markets, and Clifford Shoemaker, of the Bureau of Public Roads; and Department of Commerce, R. S. MacElwee, assistant director of the Bureau of Foreign and Domestic Commerce. The new members are Mr. Shoemaker, succeeding J. M. Goodell, who has retired from the Bureau of Public Roads, Mr. Halowell and Lieutenant Colonel Ritchie.

Shipping Board Reconstituted

Three new members of the United States Shipping Board took office last week, and the board thus again has a full quota of members. Judge John B. Payne, Commander Thomas A. Scott and H. M. Robinson are the new members, while Vice-Chairman Raymond B. Stevens and John A. Donald are the holdover members. Judge Payne has been elected chairman of the new board.

Highway Activities in New South Wales

Reports from Australia state that a good-roads movement is about to begin throughout the continent. The campaign is especially strong in New South Wales and Victoria. Legislation has already been passed facilitating the movement, and New South Wales, with its local government amendment act, has empowered shire councils to grant franchises for the development of roads, hydro-electric schemes and irrigation projects. Victoria has already its county roads commission.

Nearly 500,000 soldiers are returning home from countries where good roads are the rule rather than the exception. In each state of the Commonwealth many thousands are being settled on the land and they demand good roads.

An Anzac Highway, to extend around the Australian continent, after the plan of of the Lincoln Highway in America, has been approved by both Federal Houses of Parliament, but the work is proceeding slowly, owing to lack of labor and machinery.

English and continental machinery cannot continue to supply the Australian demand as before the war, as there are in Europe nearer markets and countries needing reconstruction. American motor cars and trucks have already appeared in the Australian market, and roads are essential for their further success and appreciation. It is also thought that American highway machinery and products will soon find a large market there.

Plumb Plan Arouses New Interest in Valuation

New interest in the physical valuation of the railroads has been aroused in Washington in view of the Plumb plan of the railway brotherhoods for the taking over of the railroads by the Government, since the sponsors of the plan have set the value of the properties a great deal lower than previous estimates. It has been noted that a certain amount of ignorance in regard to the progress of valuation work has been displayed by officials of the United States Railroad Administration. The Washington correspondent of *Engineering News-Record* reports, after an investigation in Washington, that the work of the valuation is, however, still continuing, as it has ever since 1913, when the law providing for it was passed, notwithstanding war conditions in the meantime.

At the office of Judge Prouty of the Interstate Commerce Commission's committee which has charge of the work, the statement is made that so far the cost of valuation has been $17,500,000, and that all of the field work has now been done. It is also stated that the Director of Valuation intends to release and discharge from the service, by Jan. 1, 1920, 150 engineers in each of the five districts. There are now in the employ of the Director of Valuation about 1200 men. Principally there remains only office and tabulation work to be done.

In 1913 Congress appropriated $250,000 for the work. An examination of the appropriation bills since then shows that up to May 31, 1917, $8,250,000 had been paid. In 1918 the appropriation bill carried $3,500,000, and in 1919 the same amount. The current appropriation bill, which became effective July 1, 1919, and which will expire on the same date next year, carries an appropriation of $2,500,000 for the work.

It is stated at the office of the director, as noted above, that, since the work began in 1913, seventeen odd millions of dollars have been spent, and that the division has succeeded in announcing the physical valuation of about 20 small railroads in the Southern and Southwestern sections of the United States.

Colonel Mears Chairman of Alaska Railroad Commission

Col. Frederick Mears, formerly of the 31st Engineers and in charge of the transportation of American forces in France, has been made chairman and chief engineer of the Alaskan Engineering Commission, in charge of building the Government railroad.

Colonel Mears left Washington Aug. 9 for Seattle, Wash., where he is expected to arrive Aug. 14. He will sail immediately for Alaska on an inspection tour of the Government railroad. With Colonel Mears will be John W. Halowell, assistant to the secretary of the Interior and in charge of the Alaskan Engineering Commission, and Col. George Slade, of the Northern Pacific Railway.

During the war William C. Edes was the chairman, and for some time the only member, of the commission. Colonel Mears resigned in January, 1918, to join the American forces in France, and Thomas Riggs, Jr., the other member, resigned in April, 1918, to become Governor of Alaska. Colonel Mears now remains the only member of the commission, and, owing to the fact that its funds are quite low, it is not likely that other members will be appointed this year.

William C. Edes, retiring chairman, has been appointed consulting engineer of the commission.

Court Rules Lower Otay Dam Failure Was "Act of God"

The Superior Court of California has rendered a decision in the case brought by the land owners of Otay Valley against the City of San Diego in an endeavor to collect for damages caused by the failure of the Lower Otay dam. This was an earth and rock-fill dam that failed Jan. 27, 1916. The failure was described in *Engineering News* of Feb. 3 and 17, 1916, pp. 236 and 334, and also in *Engineering Record* of Feb. 12, 1916, p. 225. The court held that the failure was caused by an "act of God" and that the city is not responsible.

Classification and Pay of State and Municipal Engineers

In furtherance of a plan to determine what changes should be made in the compensation of engineers working for salaries, the state and municipal section of Engineering Council's committee on the classification and compensation of engineers (29 W. 39th St., New York City) has prepared a tentative classification of engineering positions in state, county and municipal service. Copies of this classification, accompanied by a questionnaire as to compensation paid July 1, 1915, July 1, 1919, and compensation recommended, are being sent by the section committee named to all state engineers and state highway engineers and to all city engineers in places of 100,000 population and over—a total of 161. Recipients of the questionnaire are requested to vote yes or no as to concurrence in the classification proposed by the committee; to offer remarks upon the "present morale of the service reported on"; and to suggest "the course to be pursued in order to insure recognition of the results of this investigation." The section committee consists of Arthur S. Tuttle, deputy chief engineer, Board of Estimate and Apportionment, New York City; Frederick W. Cappelen, city engineer, Minneapolis, Minn., and M. M. O'Shaughnessy, city engineer, San Francisco.

Shipyards Consolidate

Formal merging of the Chester Shipbuilding Co. with the Merchant Shipbuilding Corporation under the name of the latter has just been announced. Both properties have been under the same ownership, with identical officers, and the present consolidation is essentially a reorganization of management. The Merchant yard, one of the three original Government agency yards, is located at Bristol, Penn., and has 12 building ways. The Chester yard, at Chester, Penn., is an expansion from the old yard of John Roach, the oldest steel shipyard in the country; it has been building ships on seven ways.

Contributions from Engineers, Architects and Constructors' Conference on National Public Works

M. O. LEIGHTON, Chairman

PUBLISHER'S NOTE: *The space occupied under this caption is donated to serve as a means of frequent and intimate communication between the Engineers, Architects and Constructors' Conference on National Public Works, and the members of the profession. The contributor takes full authority for the statements made.*

UNITED STATES COAST AND GEODETIC SURVEY

The latest bulletin from the Engineers, Architects and Contractors' Conference on National Public Works deals with the work of the United States Coast and Geodetic Survey and other Government agencies engaged in mapmaking. An analysis of all the activities of the Survey, according to the bulletin, shows the work to be entirely technical and largely engineering in the strictest sense. It is contended that the entire activities of this bureau coud well be coördinated with those of the other mapmaking agencies of the Government thereby bringing about an improvement in the amount and character of the work done. The bulletin says, in part:

SHOULD CO-ORDINATE SURVEYS

The results of the Survey's work are made use of by commerce, by railways, by land owners of every kind and by all enterprises whose primary investigations require the use of maps. The putting of all of these surveys, whether by land or by sea, under the Bureau of Public Works would insure a comprehensive mapping plan and the use of consistent scales and legends on all maps, and would bring together a permanent corps of skilled surveyors who would be capable of mapping the interior of the United States with such exactitude as would make their results of unlimited value in time of peace, and in war their maps would be the basis of all war operations even as the French maps were recently.

Instead of 12 independent bureaus making surveys, each without liaison with the other 11, there would be one central department planning and conducting this work, weighing the comparative needs of different sections and so directing the efforts of the department that the greatest good to the greatest number would result

These maps, under a unified control, would be made with sufficient detail and exactness to cover the most particular needs. The information once gathered, it would be comparatively simple to adapt it for any special purpose, whether it be war, idustry or commerce.

There is no work that this Survey does that does not fit in well with the work planned for the Department of Public Works. It is essentially an engineering work and consequently belongs in the national Department of Public works, together with the other engineering activities of the Government.

Strengthening of Patent Office Legislation

The patents committee of Engineering Council has collaborated with the similar committee of the National Research Council in developing a scheme for the improvement of the method of dealing with patents in this country. The staff of the Patent Office is itself actively engaged in this effort. Out of the report prepared by the National Research Council, and approved and adopted by Engineering Council as the report also of its patents committee, remedial legislation has taken form. Three bills have been introduced, as follows: One, known as H.R. 5011, is a bill to make the Patent Office independent of the Department of the Interior or any other department, and to simplify the procedure of the courts with reference to assessment of damages or profits for infringement of patents; H.R. 5012 is a bill to establish a single court of patent appeals, and H.R. 7010 is a bill to increase the force and the salaries in the Patent Office. Chairman Charles A. Terry, of the patents committee of Engineering Council, requests that those interested write to their Congressmen, urging the passage of these bills.

American Chemical Society Will Meet September 2-6

The autumn meeting of the American Chemical Society will be held at the Bellevue-Stratford Hotel, Philadelphia, under the auspices of the Philadelphia section of the society, Sept. 2-6. Two new divisions of the society will hold their first meetings. One session will be addressed by Secretary of War Baker.

Civil Service Examinations

Canada—Junior engineer, Department of Public Works, Prince Rupert, B. C., $1680 per year. Application forms may be obtained from the offices of the Employment Service of Canada or the Secretary of the Civil Service Commission, Ottawa, and must be filed not later than Aug. 29.

New York—Inspector of engineering work, county service, $960 per year. File application before Aug. 20; Sanitary engineering inspector, State Department of Health, $1,260 per year. Applications must be filed not later than Aug. 20. Statistician, Bureau of Statistics and Information, State Industrial Commission, $1,500 to $1,800 per year. Applications must be filed before Aug. 20; Albany, N. Y.

United States

For United States civil service examinations, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Patent investigator, patents section, War Department, $1200 to $1800 per year. File applications before August 26.

Expert patent investigator, patents section, War Department, $1800 to $2400 per year. File applications before Aug. 26.

Research engineer, $2,800 to $3,200 per year, Ordnance Department. File application before Sept. 2.

Plant superintendent, $2,000 to $2,400 per year, Ordnance Department. File application before Sept. 2.

Research physicist, $2,700 to $3,200 per year, Ordnance Department. File application before Sept. 2.

Radio engineer, $3,000 to $4,800 per year; assistant radio engineer, $2,000 to $3,000 per year; radio laboratory assistant, $800 to $2,000 per year, Signal Service, War Department. File application before Sept. 2.

Mathematics and dynamics experts, Grade I, $2,500 to $4,000 per year; Grade II, $4,000 to $5,000 per year, Ordnance Department. File application before Sept. 2.

Specification engineer, $2,400 per year; Chief Signal Officer's Office, War Department. File application before Sept. 9.

Chief metallurgist, $4,500 to $5,000 per year; assistant chief metallurgist, $3,600 to $4,500 per year, Ordnance Department. Applications must be filed before Sept. 16.

Junior highway bridge engineer, Office of Public Roads and Rural Engineering, Department of Agriculture, $1200 and $1600 per year, Sept. 17.

Computer, Ordnance, Navy Yard, Washington, D. C., $7.20 to $12 per diem, Sept. 17. File applications in time to arrange for examination at place selected by applicant.

Assistant examiner, Patent Office, Washington, D. C., $1500 to $1740 per year, Sept. 17 to 19 and Nov. 19 to 21. File applications in time to arrange for examination at place selected by applicant.

Engineer, $3000 per year; assistant engineer, $1800 to $2880 per year; junior engineer, $1200 to $1740 per year; engineering draftsman, $1200 to $3000 per year, Reclamation Service Applications will be received until further notice.

ENGINEERING SOCIETIES

Calendar

Annual Meeting

NEW ENGLAND WATER WORKS ASSOCIATION Tremont Temple, Boston, Sept. 30, Oct. 1-3, Albany, N. Y.

AMERICAN SOCIETY OF NAVAL ENGINEERS; Sec. Lieut. Com. F. W. Sterling, U. S. N., Navy Department, Washington, D. C.; Oct. 7, Washington.

AMERICAN PUBLIC HEALTH ASSOCIATION; 169 Massachusetts Ave., Boston; Oct. 27-30, New Orleans.

The Duluth Engineers' Club, at its monthly meeting Aug. 4, adopted a report prepared by a committee composed of Frank Hutchinson, Dwight E. Woodbridge and W. H. Woodbury, recommending the construction at the earliest possible date of a channel from Lake Superior ports to Atlantic tidewater, to be of sufficient depth to provide for the passage of seagoing vessels drawing 21 ft. of water, and with provision to use the water-power that would be made available. The resolution commended the efforts of the Great Lakes Tidewater Commission, and urged upon the state's senators and representatives in Congress that they promote the project in every way possible. A resolution was adopted indorsing the bill to establish a national Department of Public Works. The following officers were elected: President, Col. F. A. Pope; vice-presidents, W. A. Clark and J. L. Pickles; treasurer, A. V. Shipman, and secretary W. H. Woodbury.

The Oregon Society of Engineers unanimously voted at its meeting July 24 to amalgamate with the American Association of Engineers.

The New York Chapter of the American Association of Engineers held a meeting in the Engineering Societies' building, Aug. 13.

The Colorado Society of Engineers held Aug. 1 its monthly meeting, which was devoted to a discussion of national engineering questions. Recommendations for the speedy completion of the topographic mapping of the country were approved, and the committee on national affairs reported favorable replies from all the state's Congressmen. Active support was promised by the Wyoming and Idaho state societies. Favorable action was taken on the soldiers' settlement bill, and sentiment was expressed in favor of the bill for a national Department of Public Works. Affiliation with a national organization, either the American Association of Engineers or some organization yet to be formed including all societies, was discussed, and the question was left in the hands of a committee consisting of Hugh Glen, V. B. Wagner and R. M. Hosea, to make a recommendation on which a letter ballot may be taken.

PERSONAL NOTES

WALTER JACKSON, for 17 years associated with the *Electric Railway Journal*, first as associate editor and then as business manager, has resigned in order to engage in consulting work on the application of zone fare systems to electric railways and the coördination of bus and electric-railway service. He recently completed a four-months' study in England of both of these subjects. He has written extensively on electric-railway matters and is co-author with Henry W. Blake of a book entitled "Electric Railway Transportation." Mr. Jackson's offices will be at 567 8th St., Brooklyn, N. Y.

HARRY N. JENKS has returned to this country from his position as sanitary engineer, Burma Mines, Ltd., Namtu, Burma, and has become assistant engineer under C. G. Gillespie, director, bureau of sanitary engineering, California State Board of Health, with headquarters at Berkeley. Mr. Jenks is the author of the article, "Sanitary Engineers Get Direct Results in East Indian Mining Camp," which appeared in *Engineering News-Record* of Jan. 23, 1919, p. 172.

ROBERT B. HOADLEY, formerly county assistant, New York State Highway Department, with headquarters at Binghamton, and JOHN A. GILES, formerly commissioner of public works and city engineer of Binghamton, have formed the firm of HOADLEY & GILES, Phelps Bldg., Binghamton, N. Y. They will conduct a general practice, specializing in municipal work, highways, subdivision and topographical surveys.

DELANO & ALDRICH, architects, and the firm of CHARLES H. HIGGINS, architects and engineers, have discontinued the business association they had during the war. Each firm will continue its practice, Delano & Aldrich at 126 E. 38th St., and Charles H. Higgins at 19 W. 44th St., New York City.

LIEUT. COL. HENRY S. SPACKMAN, Corps of Engineers, U. S. A., returned to this country July 18 and received his discharge from the service. He has resumed his work as president of the HENRY S. SPACKMAN ENGINEERING CO., engineers, chemists and inspectors, Philadelphia. He reported for active service in July, 1917, and was assigned to duty with the officer in charge of cantonment construction, later becoming constructing quartermaster at Camp Merritt, New Jersey. He left for France in September, 1917, and later served as chief of the cement section. Last January he was assigned to duty with the peace commission as technical adviser, Department of Finance and Economics, War Damages in Allied Countries, and was engaged in the determination of damages to France, Belgium, Italy, Serbia, Roumania and Greece. He has recently been attached to the Army Educational Commission in Paris as director of the bureau of institute organization and industrial problems.

CAPT. JACK J. HINMAN, JR., Sanitary Corps, U. S. A., who has been engaged in water-supply work in France, has received his discharge from the service and has returned to his work as water bacteriologist and chemist for the Iowa State Board of Health and assistant professor of epidemiology in the State University of Iowa, Iowa City.

ROBERT COLTMAN, JR., who was recently connected with BARCLAY PARSONS & KLAPP, consulting engineers, New York City, in the construction of the twin graving docks for the Emergency Fleet Corporation at Norfolk, Va., has become construction engineer for the American Mongolian Trading Co. at Kalgan, China.

GEORGE F. COTTERILL, chief engineer of the state highway department, Olympia, Wash., since 1916, has resigned. COMMISSIONER JAMES ALLEN will continue to exercise supervision over the engineering work that is directly administered by resident engineers in the various highway districts.

F. D. MESSENGER is now on inactive duty as assistant sanitary engineer, United States Public Health Service, and has become an engineer in the office of the state highway department, Lansing, Mich. While in the service he was in charge of antimalarial operations in the Camp Logan zone, Houston, Tex.

LIEUT. JACK T. NASH, Engineers, U. S. A., has received his discharge from the service and has resumed his connection with the HENRY EXALL ELROD CO., as chief office engineer, at Dallas, Tex.

ALFRED WALDRON SMITHERS, chairman of the board of directors of the Grand Trunk Railway System of Canada, has been granted knighthood by King George V.

T. DANTZIG, G. A. PFEIFFER, and J. F. RITT have become associated under the firm name of DANTZIG, PFEIFFER & RITT, consulting mathematicians, 500 W. 116th St., New York City, and will specialize in problems arising in industry for the solution of which the knowledge of mathematical specialists may be necessary. Dr. Dantzig is a graduate of the University of Paris and of the École Supérieure d'Aëronautique et de Construction Méchanique. He has taught at Indiana University and at Columbia University. During the war he was in charge of the mathematical work of the instrument section of the

United States Ordnance. Dr. Pfeiffer received the degree of mechanical engineer from Stevens Institute of Technology and the degree of doctor of philosophy from Columbia University. He has taught mathematics at Harvard, Princeton and Columbia, and he is an associate editor of the *Annals of Mathematics*. Dr. Ritt took the degree of doctor of philosophy at Columbia University. He was for three years at the Naval Observatory and has since taught mathematics at Columbia; during the war he was one of the chief ballisticians in the United States Ordnance.

B. W. MATTESON, formerly in the city engineer's office, Los Angeles, Calif., is now connected with the Bureau of Public Roads, Department of Agriculture. His headquarters are at Enterprise, Utah.

CHARLES A. HASKINS, until recently captain in the Sanitary Corps, U. S. A., on duty in the office of the Surgeon General, has been appointed director of the division of water and sewage, Kansas State Board of Health.

ALLAN WATERS, for five years supervising architect for the British Columbia Government, and for the past 2½ years in overseas war service, has located for practice of his profession in Seattle, Wash.

J. C. TOWNLEY, formerly superintendent of public works, Ithaca, N. Y., who recently received his discharge from the 23rd Engineers, U. S. A., has been appointed assistant engineer with HUGH L. COOPER & CO., hydro-electric engineers, New York City, with headquarters at Massena, N. Y.

W. C. MAURICE, assistant engineer, New York Central R.R., has been temporarily assigned to special work in the engineering and maintenance section, division of operation, United States Railroad Administration, with office in Washington, D. C.

JOHN REVELL, who for the past year has been engaged as assistant engineer in the construction of Camp Knox, Kentucky, has been appointed chief draftsman, Kentucky Department of Public Roads, at Frankfort.

A. S. ADAMS has temporarily suspended his engineering practice in the Union National Bank Bldg., Houston, Tex., to become general superintendent of the refinery department, Humble Oil & Refining Co., Baytown, Tex.

COL. A. MCPHAIL, C.M.G., D.S.O., has returned from the Canadian forces overseas and resumed his former position as head of the department of civil engineering at Queens University, Kingston, Ont.

GILBERT K. COOPER and GEORGE B. MCCLARY have become associated under the firm name of COOPER & MCCLARY, civil engineers, 343 S. Dearborn St., Chicago, and will engage in general practice. Mr. Cooper was field engineer for the Chicago Union Station Co., and Mr. McClary has served as field engineer for the same company since receiving his discharge as captain of engineers, United States Army.

T. CANBELL, provincial government engineer, St. Boniface, Man., has been elected a member of the Royal Society of London.

W. F. DUGAY and G. A. PRINGLE, Seattle, have formed a partnership and opened offices as consulting engineers and contractors in steam and hot-water heating, at 201 Boston Building.

C. L. POST, vice-president of the CONDRON CO., engineers, Chicago, has taken charge of the newly-created branch of that company at Akron, Ohio.

CARL F. MEYER has resigned as chief engineer of the MORGAN PARK CO., Duluth, Minn., after six years' service with it and associated engineering firms.

BLAIR BOYLE, county engineer of Geary County, Kansas, has resigned to accept appointment as county engineer of Bourbon County, Kansas.

T. A. GARROW has resigned as city engineer of The Dalles, Oregon.

LIEUT. FRANK MITCHELL, engineers, U. S. A., who recently returned to this country and received his discharge from the service, has been appointed highway engineer of Thomas County, Georgia.

T. H. JOHNSON has resigned as city engineer of Sioux City, Iowa, and A. M. SCHOTT has been named acting city engineer.

GEORGE H. HALEY, Watertown, N. Y., has become associated with the du Pont Construction Co., Wilmington, Del., as a construction engineer.

V. V. LONG has opened offices in the Colcord Bldg., Oklahoma City, Okla., under the firm name of V. V. LONG & CO., to conduct an engineering practice in municipal improvements.

OBITUARY

FREDERICK J. REMMERS, president, Frederick Remmers Construction Co., St. Louis, died recently in that city. At the age of 24 he organized the Remmers Construction Co., of which he was president for more than 55 years.

Common Brick Manufacturers' Association to Advertise

A national advertising campaign is proposed by the Common Brick Manufacturers' Association of America, which held its first annual convention in Chicago in February, 1919. At that time it was proposed to adopt a trademark to be molded in every brick manufactured by the members of the association, irrespective of the company. This measure has now been adopted, and the association proposes to enter upon a nation-wide campaign to keep the advantages of common building brick before the public.

In furtherance of this plan, the association has issued a pamphlet, 13 x 20 in., the subject of which is a national campaign to educate the public in the use of common brick and to build business. The pamphlet deals with the need for publicity in its various phases. The association has also issued some smaller booklets, descriptive of the association and its aims.

International Trade Conference To Be Held at Atlantic City

An international trade conference is announced for Atlantic City during the week of Sept. 29. Invitations have been extended by the Chamber of Commerce of the United States to Great Britain, France, Italy and Belgium for a joint commercial mission to visit this country in the autumn and attend the conference. It is intended that the mission shall tour the country after the conference, visiting the chief industrial and commercial centers.

The main purpose of the visit and of the international trade conference is to acquaint American business men with the situation abroad, and to bring about closer relations between this country and its European associates in the war. It is felt that unless the European countries can begin production on a large scale they are faced with a serious danger in that they may not be able to pay for food and clothing which they need, and meet other obligations.

At Atlantic City questions regarding financial and trade relations with foreign countries will be taken up and discussed. That the missions will have standing is evidenced by the fact that at least two will be headed by cabinet members, and each will be accompanied by a Government representative. Each will include five principals and a number of assistants and secretaries, making a party altogether of 50 or 60. It is estimated that the conference will be attended by at least a thousand leaders of American business.

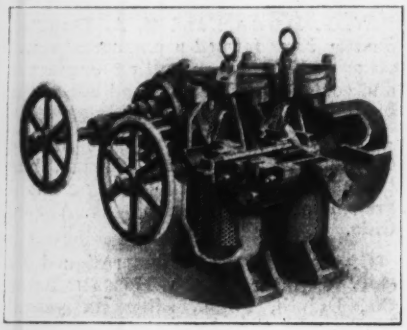
A. C. Bedford, chairman of the Standard Oil Co. of New Jersey, will act as chairman of both the general and the executive committees. Among the members of the executive committee will be Homer L. Ferguson, president of the United States Chamber of Commerce; Thomas W. Lamont, of J. P. Morgan & Co.; James A. Farrell, chairman of the National Foreign Trade Council; William F. Morgan, president of the Merchants' Association of New York. Further information may be obtained by addressing Elliott H. Goodwin, general secretary of the Chamber of Commerce of the United States, at Washington, D. C.

Duplex Strainer for Water or Oil

A duplex strainer, designed for installation in the suction of discharge lines of lubricating- or fuel-oil systems for the removal of solids in suspension, and suitable also for straining the water-supply from such sources as rivers and lakes to prevent the entrance of weeds, sticks, marine plants and small fish into the pipe lines, is shown in the accompanying illustration.

Such foreign material, if not removed from the oil, makes the lubrication inefficient, and may seriously damage the bearing surfaces. Similarly, sediment in fuel oil tends to clog the burners, reducing their capacity and necessitating frequent cleaning. The necessity of removing such solids from water is well understood.

The strainer consists of a cast-iron body containing two perforated steel or brass baskets. The valve arrangement permits the complete removal and cleaning of either basket while the other remains in service. In operation, the oil or other liquid enters the inlet connection of the strainer and passes into the basket that is in service, the solid matter remaining in the basket while the liquid passes through the perforations and thence out of the strainer. All the cast-iron sections are cylindrical, resulting in maximum strength. The valve mechanism is very simple



DUPLEX STRAINER OPENED TO SHOW BASKETS

and the valves are easily reground. The apparatus is manufactured by the Griscom Russell Co., 90 West St., New York City.

Business Notes

THE INDEPENDENT PNEUMATIC TOOL CO., 600 W. Jackson Boulevard, Chicago, announces that Sergeant Paul Mitchell has returned from service with the American Expeditionary Forces in France, and has resumed his duties as traveling representative for the company.

THE CHICAGO PNEUMATIC TOOL CO., Fischer Building, Chicago, has appointed J. L. Canby as district manager of sales at Chicago, succeeding Nelson B. Gatch, who has been transferred to New York as district manager of sales.

PAUL KIRCHER, sales engineer of the Massey Concrete Products Corporation in Chicago, has been transferred to New York and has become resident manager, reporting to Charles Gilman, vice-president, in charge of the Massey interests in the East.

THE AMERICAN STEAM CONVEYOR CORPORATION, engineering and contracting, Chicago, has appointed Thomas O. Morgan, until recently head of the service department of the New York office, sales engineer. He will handle the Long Island and Connecticut territory. H. S. Valentine has also been appointed sales engineer in charge of the Philadelphia territory, with offices in the North American Building. Mr. Valentine is a mechanical engineer and was connected with the Link Belt Co. of Philadelphia for 5½ years. He has also been associated with the Brown Hoisting Machine Co., the Yale & Towne Manufacturing Co. and the Badenhausen Company.

THE PETROLEUM REFINING CO., of Texas has changed its corporate name to the Galina-Signal Oil Co. Its offices are at 1504 Carter Bldg., Houston, Tex.

THE GREEN ENGINEERING CO., East Chicago, Ind., has appointed the firm of Bull & Livensparger as its sales representatives in Chicago and Northern Illinois territory. The latter firm will take charge of the Chicago sales office at 14 E. Jackson Boulevard. Messrs. Bull and Livensparger have been connected with the company for several years.

THE AUSTIN CO., industrial engineers and builders, Cleveland, Ohio, has appointed F. W. Mettler as director of purchases, to succeed F. B. Gerard, who has resigned to become general manager of Pilkington Bros. Co., Ltd., at Thorold, Ont.

THE YOUNGSTOWN STEEL CAR CO., Youngstown, Ohio, has appointed George J. Lynch sales manager, with headquarters at Youngstown.

THE FOUNDATION CO., Woolworth Bldg., New York City, announces that it has established offices at 16 Rue de La Pépinière, Paris, and is prepared to undertake operations in European countries. American corporations contemplating engineering or construction work abroad can arrange at the New York office of the Foundation Co. for the carrying out of the details of the project. The French organization, which operates under the name of "Fondations, Constructions, Travaux Publiques," includes engineers who have had years of experience with the Foundation Co. At a recent meeting of the board of directors Franklin Remington was elected chairman of the board, John W. Doty was elected president of the company, and Harry J. Deutschbein was elected first vice-president and general manager.

THE BLAW-KNOX CO., manufacturer of steel products, Pittsburgh, Penn., has recently completed a playground at its plant at Hoboken, Penn., to be used by the children of the employees. The center is complete in every detail, including a swimming pool, and is intended for employees as well as their children.

Trade Publications

The followng companies have issued trade publications:

THE BARBER ASPHALT PAVING CO., Land Title Building, Philadelphia, Penn.; bulletin No. 6, 8 x 10½ in., eight pages, illustrated; subject, Iroquois asphalt paving tools.

THE WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J.; booklet, 5 x 7 in., 16 pages, illustrated; tells of the effects of corrosion of condenser tubes, gives price list of seamless tubes, weight per lineal foot for various diameters, and other information.

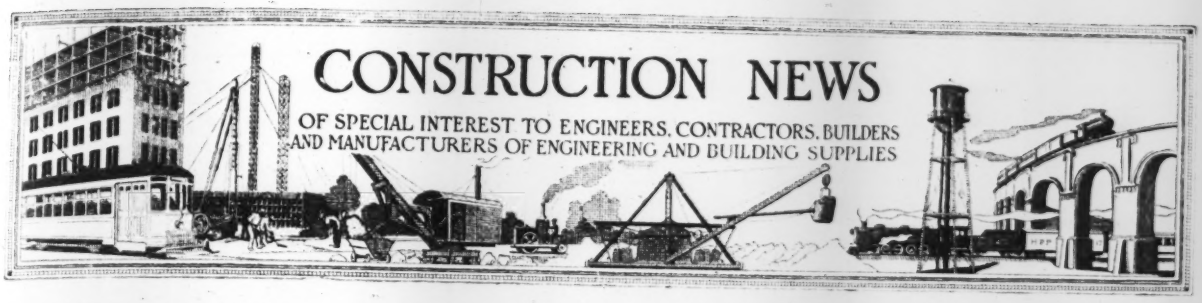
THE COMBUSTION ENGINEERING CORPORATION, of New York; bulletin No. G-1, 6 x 9¼ in., 20 pages, illustrated; the subject is grates for the promotion of combustion.

THE A. LIETZ CO., 61 Post St., San Francisco, Calif.; catalog, 6¼ x 9¼ in., 612 pages, illustrated; it lists the company's surveyors' and engineers' instruments and a large number of engineering books and publications. The company carries a stock of engineers' and surveyors' instruments.

THE BEDFORD FOUNDRY & MACHINE CO., Bedford, Ind., manufacturer of cranes and derricks; catalog, 8¾ x 11¼ in., 59 pages, illustrated; its subject is Bedford cranes and derricks.

THE GUARANTY TRUST CO., 140 Broadway, New York City; bulletin, 6½ x 9½ in., 28 pages, illustrated; subject, "Trading With Mexico Today."

THE UNITED AIRCRAFT ENGINEERING CORPORATION, of New York, has just issued an interesting booklet entitled "Commercial Aviation and Its Relation to the Community." It is the first of a series which will show in its true light the present status of commercial aviation and its future possibilities; the booklet is 4 x 9¼ in. and contains 18 pages. Among other subjects it has pages devoted to the types of aircraft, speed, endurance, landing, load, altitude, safety and cost of operation.


CONSTRUCTION NEWS
OF SPECIAL INTEREST TO ENGINEERS, CONTRACTORS, BUILDERS
AND MANUFACTURERS OF ENGINEERING AND BUILDING SUPPLIES

PROPOSALS

"For Proposals Advertised see the pages immediately following the Construction News Section."

WATERWORKS

Bids Close		See Eng. News-Record
Aug. 18	Garber, Okla.	Aug. 7
Aug. 18	Ashland, Ky.	Aug. 14
Aug. 19	Philadelphia, Pa.	Aug. 14
Aug. 20	Armour, S. D. Adv. July 24.	July 24
Aug. 20	Hawthorne, N. J. Adv. Aug. 14.	Aug. 14
Aug. 25	Grey Bull, Wyo.	Aug. 14
Aug. 25	Royal Oak, Mich.	Aug. 14
Aug. 30	Berwick, N. S.	Aug. 14
Aug. 30	Clarksburg, W. Va. Adv. Aug. 7.	Aug. 7

SEWERS

Aug. 18	Hackensack, N. J. Adv. July 24.	July 24
Aug. 18	Huntington, Pa.	July 31
Aug. 18	St. Paul, Minn.	Aug. 14
Aug. 18	Harrisburg, Pa.	Aug. 14
Aug. 18	Detroit, Mich.	Aug. 14
Aug. 18	Crisfield, Md.	Aug. 7
Aug. 18	Paulsboro, N. J. Adv. Aug. 7.	Aug. 7
Aug. 18	Towson, Md.	Aug. 7
Aug. 19	Toledo, O.	Aug. 14
Aug. 19	Kansas City, Mo. Adv. July 3 to 17.	July 3
Aug. 20	Cartersville, Ga.	Aug. 7
Aug. 20	Philadelphia, Pa.	Aug. 14
Aug. 21	Mandan, N. D.	Aug. 7
Aug. 21	Senatobia, Miss. Adv. Aug. 14.	Aug. 14
Aug. 21	New Baltimore, Mich.	Aug. 14
Aug. 25	Walnut Grove, Minn.	Aug. 7
Aug. 25	Lima, O. Adv. Aug. 7.	Aug. 7
Aug. 25	Royal Oak, Mich.	Aug. 14
Aug. 25	Fairhaven, Mass. Adv. Aug. 14.	Aug. 14

BRIDGES

Aug. 18	Harrisburg, Pa.	Aug. 7
Aug. 18	Pritchard, B. C.	Aug. 7
Aug. 18	Pine City, Minn.	Aug. 14
Aug. 18	Harrisburg, Pa.	Aug. 14
Aug. 19	St George Island, Md.	Aug. 14
Aug. 19	Pickering, Ont.	Aug. 14
Aug. 19	Statesboro, Ga.	July 3
Aug. 19	Orangeville, Ont.	Aug. 14
Aug. 19	Port Hope, Ont.	Aug. 14
Aug. 20	Swainsboro, Ga.	July 3
Aug. 20	New Jersey Adv. Aug. 7.	Aug. 7
Aug. 20	Barrington, R. I.	Aug. 14
Aug. 20	Albany, Ore.	Aug. 14
Aug. 20	Michigan	Aug. 14
Aug. 25	Willougby, O.	Aug. 7
Aug. 25	Great Falls, Mont.	Aug. 7
Aug. 25	Underwood, Wash.	Aug. 14
Aug. 26	Lockhart, S. C. Adv. Aug. 14.	Aug. 14
Sept. 1	Duluth, Minn.	Aug. 14
Sept. 2	Minneapolis, Minn.	Aug. 14
Sept. 3	Toledo, O.	Aug. 14
Sept. 9	Duluth, Minn.	Aug. 14
Sept. 23	Harrisburg, Pa. Adv. Aug. 14.	Aug. 14

STREETS AND ROADS

Aug. 16	Michigan	Aug. 14
Aug. 16	Granite City, Ill. Adv. Aug. 14.	Aug. 14
Aug. 18	Walnut Ridge, Ark. Adv. July 17.	July 17
Aug. 18	Trenton, Ont.	Aug. 7
Aug. 18	Beamsville, Ont.	Aug. 7
Aug. 18	London, Ont.	Aug. 7
Aug. 18	Brantford, Ont.	Aug. 7
Aug. 18	Kingston, Ont.	Aug. 7
Aug. 18	Brockville, Ont.	Aug. 7
Aug. 18	California	Aug. 14
Aug. 18	Philadelphia, Pa.	Aug. 14
Aug. 18	Chester, Pa.	Aug. 14
Aug. 18	Toronto, Ont.	Aug. 14
Aug. 19	Michigan	July 31
Aug. 19	Reedsburg, Wis.	Aug. 14
Aug. 19	Manitowoc, Wis.	Aug. 14
Aug. 19	Anoka, Minn.	Aug. 14
Aug. 19	Columbus, O.	Aug. 14
Aug. 19	Michigan	Aug. 7
Aug. 19	Farmington, Minn.	Aug. 7
Aug. 19	Georgetown, Del.	July 31
Aug. 19	Faribault, Minn.	July 31
Aug. 19	Harrisburg, Pa.	July 31
Aug. 19	Michigan	Aug. 14
Aug. 20	Alabama	Aug. 14
Aug. 20	Baltimore, Md.	Aug. 14
Aug. 20	Brooklyn, N. Y.	Aug. 14
Aug. 21	De Queen, Ark.	July 24
Aug. 21	Oil City, Pa.	Aug. 7
Aug. 21	Michigan	Aug. 14
Aug. 21	Newport News, Va.	Aug. 14
Aug. 21	Michigan	Aug. 14
Aug. 21	St. George, S. I., N. Y.	Aug. 14
Aug. 22	St. George, S. I., N. Y.	Aug. 14
Aug. 22	Boise, Idaho	Aug. 14
Aug. 23	Brainerd, Minn.	July 31
Aug. 23	Montana	Aug. 14
Aug. 23	Monesson, Pa.	Aug. 14
Aug. 23	Michigan	Aug. 14
Aug. 23	Morgantown, W. Va.	Aug. 14
Aug. 24	Washington, D. C.	July 24
Aug. 24	Denver, Colo.	July 10
Aug. 25	Ebensburg, Pa.	Aug. 7
Aug. 25	Indiana	Aug. 14
Aug. 25	Washington	Aug. 14
Aug. 25	California	Aug. 14
Aug. 26	Indiana	Aug. 14
Aug. 26	Maryland	Aug. 14
Aug. 26	Bordentown, N. J. Adv. Aug. 14.	Aug. 14
Aug. 26	Trenton, N. J. Adv. Aug. 14.	Aug. 14
Aug. 26	New York, N. Y.	Aug. 7
Aug. 26	Guntersville, Ala.	July 31
Aug. 27	Peru, Neb.	Aug. 7
Aug. 27	Welch, W. Va.	Aug. 14
Aug. 27	Middletown, Del.	Aug. 14
Aug. 27	New Jersey Adv. Aug. 14.	Aug. 14
Aug. 28	Helena, Ark.	Aug. 14
Aug. 28	Martinsburg, W. Va.	Aug. 14
Aug. 28	Camden, N. J. Adv. Aug. 14.	Aug. 14
Aug. 29	Greenfield, Ind.	Aug. 14
Aug. 30	St. Martine, Que.	Aug. 14
Sept. 1	Arcadia, Fla.	Aug. 7
Sept. 1	Salt Lake City, Utah	July 24
Sept. 2	Independence, Mo.	Aug. 7
Sept. 2	Minneapolis, Minn.	Aug. 14
Sept. 2	Washington, Ga.	Aug. 14
Sept. 2	Sylacauga, Ala.	Aug. 14
Sept. 3	Toledo, O.	Aug. 14
Sept. 3	Moultrie, Ga.	Aug. 14
Sept. 8	Indiana	Aug. 14
Oct. 10	Tacoma, Wash. Adv. Aug. 14.	Aug. 14

EXCAVATION AND DREDGING

Aug. 19	Ottawa, Ont.	Aug. 14
Aug. 20	Brooklyn, N. Y.	Aug. 14
Aug. 20	Carrollton, Miss.	Aug. 7
Aug. 28	Granite Falls, Minn.	Aug. 7
Sept. 2	Sanford, Ala.	Aug. 14

INDUSTRIAL WORKS

Aug. 16	Worcester, Mass.	Aug. 14
Aug. 20	Minneapolis, Minn.	Aug. 14
Aug. 20	Philadelphia, Pa.	Aug. 14
Aug. 22	Wilkes-Barre, Pa.	Aug. 14

BUILDINGS

Aug. 16	Hazleton, Pa.	Aug. 14
Aug. 18	Erie, Pa.	July 24
Aug. 18	Ottawa, Kan.	Aug. 7
Aug. 18	Maple Shade, N. J.	Aug. 14
Aug. 18	Minneapolis, Minn.	Aug. 14
Aug. 19	Spring City, Pa.	Aug. 7
Aug. 19	Fairmont, Neb.	Aug. 7
Aug. 19	West Bethlehem, Pa.	Aug. 14
Aug. 20	Hamilton, Ont.	Aug. 7
Aug. 20	Austin, Minn.	Aug. 7
Aug. 20	Watsontown, Pa.	Aug. 14
Aug. 21	Springfield, Ill.	Aug. 7
Aug. 21	Valpariso, Neb.	Aug. 7
Aug. 21	Richmond, Utah	July 31
Aug. 21	Storm Lake, Pa.	Aug. 14
Aug. 21	Detroit, Mich.	Aug. 14
Aug. 22	Montevideo, Minn.	Aug. 14
Aug. 23	Thief River Falls, Minn.	Aug. 14
Aug. 23	Hobart, N. Y.	Aug. 14
Aug. 24	St. Paul, Minn.	July 31
Aug. 25	Elizabeth, N. J.	Aug. 7
Aug. 25	Bayard, Neb.	Aug. 7
Aug. 25	Chicago, Ill.	Aug. 7
Aug. 26	Weyburn, Sask.	Aug. 7
Aug. 26	Manhattan, Kan.	Aug. 14
Aug. 27	East White Plains, N. Y.	Aug. 14
Aug. 27	Stoutsville, O.	Aug. 7
Aug. 30	New Aberdeen, N. S.	Aug. 7
Aug. 30	Worcester, Mass.	Aug. 14
Aug. 30	Halifax, N. S.	Aug. 14
Sept. 1	Omaha, Neb.	July 17
Sept. 1	Ft. Worth Tex.	Aug. 14
Sept. 1	Cameron, Tex.	Aug. 14
Sept. 1	Miamisburg, O.	Aug. 14
Sept. 1	Outremont, Que.	Aug. 14
Sept. 3	Trenton, N. J.	Aug. 14
Sept. 3	Victoria, Tex.	Aug. 14
Sept. 4	Bayonne, N. J.	July 31
Sept. 4	Peterborough, Ont.	Aug. 14
Sept. 6	Fairview, Pa.	Aug. 14
Sept. 15	Pleasant Grove, Utah	July 24
Sept. 15	St. Paul, Minn.	Aug. 14

FEDERAL GOVERNMENT WORK

Aug. 18	Removing Boulders—Newport, R. I. Adv. July 24.	July 24
Aug. 18	Dredging—Norfolk, Va. Adv. July 31.	July 31
Aug. 19	Repairing Dike — Philadelphia, Pa. Adv. July 17 and 24.	July 24
Aug. 19	Water Pipe—Washington, D. C.	July 31
Aug. 19	Canal Wall—Washington, D. C. Adv. July 31.	July 31
Aug. 19	Water Supply — Stapleton, N. Y.	Aug. 7
Aug. 19	Repairing Wharf—Washington, D. C. Adv. Aug. 7.	Aug. 7
Aug. 20	Metal and Glass Work—Key West, Fla. Adv. July 17.	July 17
Aug. 20	Roofing — Spec. 4005 — Norfolk, Va.	July 31
Aug. 20	Torpedo Racks—Spec. 4008 —Pearl Harbor, H. T.	Aug. 7
Aug. 20	Completing Structural Shop —Spec. 3719—Mare Island, Cal.	Aug. 14
Aug. 20	[illegible]ay Wall—Spec. 3773—Charleston, S. C.	Aug. 14
Aug. 25	Fuel Oil—Washington, D. C.	Aug. 14
Aug. 25	Post Office—Mystic, Conn.	July 31
Aug. 26	Dredging—Honolulu, H. T. Adv. June 26.	June 26
Aug. 27	Sea Wall — New York, N. Y. Adv. July 31.	July 31
Aug. 27	Electric Lighting and Power System, Spec. 3982, Mare Island, Cal.	Aug. 14
Aug. 27	Dredging—Norfolk, Va. Adv. July 31.	July 31
Aug. 27	Lock and Abutment — Louisville, Ky. Adv. July 31.	July 31
Aug. 29	Post Office—Fayette, Mo.	July 24
Aug. 29	Dredging — New York, N. Y. Adv. July 31.	July 31
Aug. 29	Breakwater—Chicago, Ill. Adv. Aug. 7.	Aug. 7
Sept. 2	Towboat—Memphis, Tenn.	Aug. 7
Sept. 2	Miscellaneous Equipment—Washington, D. C. Adv. July 10 and 17.	July 10
Sept. 2	Post Office—Kansas City, Mo.	July 24

Bids Close		See Eng. News-Record
Sept. 2	Dredging, New York, N. Y...Aug. 7 Adv. Aug. 7.	
Sept. 5	Post Office — Montevideo, Minn.	Aug. 14
Sept. 8	Post Office—Carroll, Ia	Aug. 14
Sept. 10	Post Office—Douglas, Ga...	July 31
Sept. 18	Post Office—North Toledo, Kan.	Aug. 14

MISCELLANEOUS

Aug. 18	Mechanical Loader—Hastings, Minn.	July 31
Aug. 18	Culverts, Piers—Grenville, Que.	Aug. 14
Aug. 18	Cast Iron Pipe, Detroit, Mich.	Aug. 14
Aug. 18	Water Tube Boiler, etc., Webster City, Pa.	Aug. 14
Aug. 18	Paving Bricks — Montreal, Que.	Aug. 14
Aug. 19	Tracks—Philadelphia, Pa.. Adv. July 24.	July 24
Aug. 19	Channel — Prince Edwards Island	July 31
Aug. 19	Wharf — Dauphin River, Man.	Aug. 7
Aug. 19	Ottawa, Ont.	Aug. 14
Aug. 19	Cement—New York, N. Y..	Aug. 14
Aug. 20	Brooklyn, N. Y.	Aug. 14
Aug. 20	Safety Cars — Saskatoon, Sask. Adv. July 24.	July 24
Aug. 20	Creosoted Wood Blocks, Baltimore, Md.	Aug. 14
Aug. 20	Wharf—Stewart, B. C.	July 31
Aug. 20	Bulkhead, Boston, Mass... Adv. Aug. 7.	Aug. 7
Aug. 20	Retaining Wall—St. John, N. B.	Aug. 14
Aug. 22	Heating, etc., Hudson, N. Y. Adv. Aug. 14.	Aug. 14
Aug. 23	Transit Shed — Halifax, N. S.	Aug. 14
Aug. 25	Railway Ties — Toronto, Ont.	Aug. 7
Aug. 26	Column Foundations—Philadelphia, Pa.	Aug. 14
Aug. 28	Silo—Savannah, Ga.	July 24
Aug. 28	Wharf—Sillery, Que.	Aug. 14
Sept. 12	Dam—Decatur, Ill.	Aug. 14
Sept. 15	Levee—Alexandria, La.	Aug. 14
Sept. 23	Turbines, etc.—Saskatoon, Sask. Adv. July 24.	July 24

Where name of official is not given, inquiries should be addressed to City Clerk, County Clerk or corresponding official.

Waterworks

PROPOSED WORK

N. Y., Geneva—Bd. Pub. Wks. plans to install new pumping unit for water supply, 1,000,000 gal. daily capacity. J. W. Brennan, city engr.

Md., Brunswick—City soon receives bids building 3,000,000 gal. concrete storage reservoir, involving 3000 ft. 10 in. c.i. pipe with valves, 3000 cu.yd. concrete and 10,000 cu.yd. earth excav. About $30,000. Address F. L. Spitzer, clk. Norton, Bird & Whitman, 616 Munsey Bldg., Baltimore engrs.

Md., Mt. Airy—City plans to build water storage and pipe system. Bonds for $18,000 voted for project. A. R. Molesworth, mayor.

Minn., St. Paul—Bd. Water Comrs. have completed program for improvements to cover 5 years; 1920 program includes preliminary work on impounding reservoir, cost, $202,500; meters, $1,500, reservoir on Snelling Ave., $160,000, dam, $50,000; total 5 year program includes conduit from Lake Vadnais to here having 65,000,000 gal. capacity every 24 hours, $440,000, low service main from Cayuga St. to congested district and new pumps, $300,000 and 10,000,000,000 gal. impounding reservoir, $525,000. J. C. Flanagan, secy.

Mont., Ryegate—City plans to improve waterworks system. About $25,000. T. R. Atkinson, Bismark, N. D., engr.

Mo., Marysville—A. D. Hewitt, city clk., soon receives bids building water filtration plant. About $50,000.

Mo., Weston—City having plans prepared extending pipe line, also building new well and concrete reservoir. About $20,000. W. E. Rollins & Co., 209 Ry. Exch. Bldg., Kansas City, engrs.

Okla., Ada—City retained Johnson & Benham, engrs., Firestone Bldg., Kansas City, Mo., to investigate feasibility of water supply. Probable source will be from spring 13 mi. from city, to be conducted to within 1 mi. of city by gravity line and then forced to reservoirs. Present expenditure, $400,000, probable future expenditure, $300,000.

Okla., Carnegie—City election soon to vote on $30,000 bonds to extend waterworks system. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma, engrs.

Okla., Hobart—City plans election soon to vote on $250,000 bonds to improve waterworks system. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma, engrs.

Wash., Pullman — City plans to lay 1000 ft. 4 in. and 1000 ft. 6 in. c. i. mains to replace present wooden pipe. Cost to exceed $5000. C. M. Hooper, Pullman, engr.

Wash., Valley—City plans to lay 2 mi. 12 in. pipe. About $10,000. Washington Surveying & Rating Bureau, Sherwood Bldg., Spokane, engrs.

Cal., Los Angeles—Municipal Impvt. Dist. No. 10 (Westgate annexed section) defeated $90,000 bond issue to build system to distribute water from aqueduct to Angeles Mesa Dist. Noted June 26.

BIDS DESIRED

N. Y., Hudson—See "Miscellaneous."

N. J., Hawthorne—Until Aug. 20, by Boro Comrs., furnishing, laying and placing 6000 ft. 6 in. c. i. pipe, 9 hydrants and 20 valves. J. A. Shea, clk. H. J. Harder, Paterson, engr.; advertised in this issue.

Pa., Phila.—Until Aug. 19, by Bureau Water Supply, 792 City Hall, building superstructures for pumping station, placing valve boxes and furnishing meters for pumping station No. 4, Lardners Point.

Ky., Ashland — Until Aug. 18, by Bd. Water Comrs., building pumping station and filtration plant. Alvord & Burdick, 8 South Dearborn St., Chicago, engrs. Noted July 10.

Mich., Royal Oak—Until Aug. 25, by C. W. Hubbell, engr., 2348 Penobscot Bldg., Detroit, furnishing labor and material laying 15,000 ft. 6-8 in. c.i. pipe water mains in Bronx Subdivision here, for Baker Land Co.

N. S., Berwick—Until Aug. 30, by B. C. Thompson, secy. water comrs., building concrete and timber dam, 1100 ft. high, 2 ft diameter, wood stave flume, power house and wheel pit. Work involves 3000 cu.yd. earth and 1700 cu.yd. rock excav., 800 cu. yd. mass concrete, 1100 ft. 2 ft. wood stave pipe, and 18,000 ft. B.M. timber. Total cost, $27,500. S. E. March, Berwick, engr.

PRICES AND CONTRACT AWARDED

(★Indicates award of contract)

★R. I., North Smithfield (Woonsocket P. O.)—Andrews Mills Co., Branch Village, will lay 2600 ft. c.i. waterpipe and build 40 x 40 ft. rein.-con. pump house and concrete power house with 250 h.p. wheel. Work will be done by day labor.

★Minn., Montevideo — B. O. Bonn, city clk., let contract extending waterworks system, Sect. 2, to Circular Concrete Co., 846 Builders Exch., Minneapolis, $16,625; Sects. 3 and 4, to W. D. Lovel, 2247 Hendon Ave., Minneapolis, $5,621 and $19,638 respectively. Noted July 17.

★Kan., Caldwell—City let contract furnishing 5 mi. 10 in. c.i. pipe to Nat'l Cast Iron Pipe Co., Commerce Bldg., Kansas City, Mo.; laying same to Y. C. Brooks & Son., Jackson, Mich., $14,700.

★Ariz., Phoenix—City let contract draining underground waters, system to have outlet into Gila River, to C. Fisher, 845 North 6th Ave., about $125,000. Work involves 49,500 ft. 18 in. tile pipe.

★Ariz., Phoenix—Union Oil Co. of Arizona, 15th and Santa Fe Sts., will build distributing plant to consist of warehouse, office, purop house, garage, storage tanks, etc. About $100,000. Work will be done by day labor.

Sewers

PROPOSED WORK

Fla., Jacksonville—City voted $200,000 bonds to improve and build sewers. F. M. Edwards, city engr.

Fla., Seabreeze—City soon lets contract building drainage system, involving 2¾ mi. vitr. pipe, 100 catch basins and 25 manholes. C. M. Rogers, Daytona, engr.

Mich., Royal Oak—M. L. Brown & Son, engrs., 821 Chamber of Commerce Bldg., Detroit, soon lets contract furnishing labor and material for laying 2200 ft. 8 in. vitr. pipe sewer, in Vinsetta Park Subdivision, for Vinsetta Land Co. Work includes Imhoff tank, ejector station and sprinkling filter. About $25,000.

Minn., Duluth—See "Streets and Roads."

Minn., Litchfield—F. O. Holm, Village clk., soon lets contract laying 7880 lin.ft. 8 in. and 2235 lin.ft. 10 in. sewer pipe in Dists. Nos. 11, 12 and 20.

S. D., Elk Point — City election Sept. 7, to vote on bonds to build sewerage system.

N. D., Fairmont—City having plans prepared by W. C. Buck, engr., 1245 West Minehaha Parkway, Minneapolis, for sewerage system.

Wyo., Cheyenne—City voted $30,000 bonds to build storm sewers. E. W. Glafcke, city engr. Noted July 21.

Mont., Sidney—City election Aug. 26 to vote on $30,000 bonds to build 11,000 ft. 18 in. pipe sewer extensions. H. A. Thomas, Sidney, engr.

Idaho, Soda Springs—Town Council soon lets contract furnishing materials and building Sewer Dist. No. 2, involving 3218 ft. 12 in., 8500 ft. 8 in. and 6500 ft. 6 in. vitr. pipe and 5500 cu.yd. excav. A. Meyer, clk.

Ore., Portland—City soon lets contract building vitr. or cement sewers in East 37th and Raymond Ave., East 77th St., north from Oregon to Halsey Sts., Harold Ave. and 55th Ave., S. E., East 76th St. from East Burnside to East Glisan Sts. About $10,000. O. Laurgaard, city engr.

Ore., Portland—City Council adopted resolution to build vitr. or cement sewer in Glisan St. from point 100 ft. west of 10th St. to Willamette River. About $37,366. O. Laurgaard, city engr.

Ore., Portland—City Council soon lets contract building vitr. or cement pipe sewers in East 76th and East 29th Sts. and paving with asphaltic concrete No. 1 on crushed rock base or concrete Nos. 1 and 2, East 61st St. and district improvement in Farragut St. et al. About $10,000. O. Laurgaard, city engr. Noted July 10.

BIDS DESIRED

Mass., Fairhaven—Until Aug. 25, by Bd. Sewer Comrs., building 1200 lin. ft. 15 in. and 465 lin.ft. 10 in. sanitary sewers with manholes and appurtenances. Address F. M. Metcalf, 25 Merchants Bank Bldg., New Bedford; advertised in this issue.

Pa., Harrisburg—Until Aug. 18, by Supt. Streets & Pub. Impvts., Room 30, Commonwealth Trust Co. Bldg., building sewer in Penn St., from Seneca to Schuylkill Sts., and in Berkley Pl., 28 ft. east of Reservoir Park.

Pa., Phila.—Until Aug. 20, by Dept. Pub. Wks., Room 412, City Hall, building branch sewers in various streets. A. Allen, city engr.

Pa., Pittsburgh — City receiving bids building 6, 15 and 18 in. sewers in Sebring, Fallowfield, Pioneer and McConnell Aves., Veronica, Sundehan, Berthoud, Wallace and Esplanade Sts. N. S. Sprague, City County Bldg., engr.

Miss., Senatobia — Until Aug. 21, by Town, constructing system of house sewers. Work involves 8 mi. 6-12 in. pipe sewers, manholes, flush tanks, etc. H. I. Gill, clk.; advertised in this issue.

O., Toledo—Until Aug. 19, by D. H. Goodwillie, serv. dir., building Sewer No. 1363, involving 4752 ft. 8 in. vitr. pipe, 16 manholes, etc. About $10,286. H. C. McClure, city engr. Noted July 31.

Mich., Detroit—Until Aug. 18, by C. W. Hubbell, engr., 2348 Penobscot Bldg., furnishing labor and materials for trenching, backfilling and laying 4000 ft. 12-24 in. vitr. pipe sewer and 13 brick manholes in Seven Mile Rd., for Lincolnshire Land Co., c/o Engineer. About $15,000.

Mich., New Baltimore—Until Aug. 21, by C. Gibbons, city clk., laying and backfilling complete vitr. crock storm sewerage system in Main, Maria and Alfred Sts., involving 8 and 12 in. pipe. About $14,000.

Mich., Royal Oak—Until Aug. 25, by C. W. Hubbell, engr., 2348 Penobscot Bldg., Detroit, furnishing labor and material laying 15,000 ft. 8-12 in. vitr. pipe sewer, disposal plant, tanks, sand filter and pumping station, in Bronx Subdivision, for Baker Land Co. About $45,000.

Sewer (Continued)

Ia., Hartley—Until Aug. 20, by H. F. Broders, town clk., for construction of 1542 ft. rein.con. rectangular sewer, ranging in size from 5 ft. x 5 ft. to 3 ft. 6 in. x 3 ft., 386 ft. 36 in. circular sewer, vitr. or segmental block, 1340 ft. 33 in. circular sewer, vitr. or segmental block, 2679 ft. 8-24 in. vitr. sewer pipe, etc. H. R. Green, 197 North 2nd St., Cedar Rapids, engr.

Ia., Strawberry Point—Until Aug. 18, by G. Scofield, town clk., for construction of 3000 ft. 8 in. tile sewer, 1400 ft. 6 in. tile sewer, septic tank, dosing chamber, sand filter bed and sludge basin. H. R. Green, 107 North 2nd St., Cedar Rapids, engr.

Minn., St. Paul—Until Aug. 18, by H. W. Austin, city purch. agt., City Hall, building sewers in Cleveland Ave. between University, Myrtle and Wabash Aves., 360 ft. south; James and Juliet Sts. between Underwood Ave. and 185 ft. west of Snelling Ave.; Macalester Ave. between Jefferson Ave., 75 ft. north Juliet Ave. from Juliet St. to point 75 ft. north Palace St.; from Palace St. to point 75 ft. north James St.; James St. to point 75 ft. north Randolph St. O. Claussen, city engr.

PRICES AND CONTRACTS AWARDED
(★Indicates award of contract)

★**R. I., Providence**—City let contract building vitr. sewers in Magnolia St., Freeman Parkway and Laurel Ave., to M. A. Gamino Constr. Co., 428 Grosvenor Bldg.; Delaine St., to N. W. Colgrove, Providence. Total cost, $75,000. Noted July 10.

★**Conn., Portland**—City let contract building vitr. tile sewer in Ocean St., to G. Dascanio, Portland, $10,753.

★**N. Y., Syracuse**—Bd. Contr. & Supply let contract building Sect. D., 17th Ward sewer, to Mondo Constr. Co., Kirk Bldg., $80,507. Noted July 31.

★**N. J., Westmont**—City let contract to W. P. Corson, 1141 Sycamore St., Camden, building 9 mi. sanitary sewerage system, $62,691; disposal plant and pumping station, $26,284. Noted July 31.

★**Pa., Hamarville**—Consumers' Mining Co. let contract building sewage disposal plant, to Pihl & Miller, Wabash Bldg., Pittsburgh. Cost to exceed $10,000.

★**Pa., Pittsburgh**—City let contracts building sewers in Stafford Ave. between Cherry and Chestnut Sts., and Poplar St. between 21st and 26th Sts., to Mayer Bros. Constr. Co., Commerce Bldg., $11,697 and $15,528, respectively; 4th St., between East and Dunn Sts., to J. F. M. Doyle, $7666.

★**N. C., Goldsboro**—City let contract for labor for installing 53,000 ft. 8-12 in. tile sewer pipes in all unsewered streets, to Sullivan, Long & Hagerty, Bessemer, Ala., $53,000; pipe, to Chattanooga Sewer Pipe Co., Ft. Gpie, Chattanooga, Tenn., $11,000. Noted July 10.

★**N. C., Tarboro**—City let contract for labor, for installing 14,400 ft. 6, 8 and 12 in. vitr. sanitary sewers, to F. G. McGuire, 601 Paul-Gale-Greenwood Bldg., Norfolk, Va., $19,135; pipes, to Chattanooga Pipe Wks., Ft. Gpie, Chattanooga, Tenn. $3,025.

Mich., Detroit—City received bids building Virgina Park Relief Sewer from Wilson to 14th Aves., involving 1920 ft. 4 ft. brick or concrete sewer, from W. Blanck & Co., 330 Longfellow Ave., $34,887; Jeynes & Affeld, 1208 Ford Bldg., $37,422; J. Winterbottom, 3274 West 25th St., Cleveland, $39,900.

★**Mich., Detroit**—City let contract building 5200 ft. sewer in Mack Ave. Pub. Sewer, to J. Porath, 34 McGraw Bldg., $118,914. Noted Aug. 7.

★**Ia., Marshallton** — City let contract building sewers in Dist. No. 5, to Anderson & Emple, Marshallton. About $10,000.

★**Minn., Austin**—City let contract building sewers in Hope, Ash and Clark Sts., to De Graff Wolff, 985 Schaffer St., St. Paul, $12,366. Noted July 31.

★**Neb., Lincoln**—City rejected bids received Aug. 2, building 14,800 ft. sanitary sewers. Work will be done by day labor. G. W. Bates, city engr. Noted July 17.

★**Mo., Milan**—City let contract building complete sanitary sewers and sewage disposal plant, to J. O'Neil, Leavenworth, Kan. About $29,000.

★**Okla., Idabell**—City let contract building main sewers and a sewage disposal plant, to Empire Constr. Co., Kansas City, Mo., $65,000 and $54,800 respectively. Noted July 17.

★**Wash., Seattle** — See "Streets and Roads."

Ore., Portland — City Council received bids building sewerage system in East 38th and Knight Sts., from J. Keating, Portland, $12,704, Jacobsen-Jensen Co., 407 Stanton St., $12,585, Azar & Co., Portland, $12,439.

Bridges

PROPOSED WORK

Fla., Jacksonville—City voted $200,000 to improve and build bridges. F. M. Edwards, city engr.

Minn., Fergus Falls—City soon receives bids building 2 concrete bridges, 90 ft. span, 52 ft. wide. About $16,000. A. C. Eschweiler, 720 Goldsmith Bldg., Milwaukee., Wis., engr.

Neb., Henry—Scotts Bluff Co. (Gering) having plans prepared and soon receives bids building rein.-con. arch bridge here, to have twelve 50 ft. spans and 16 ft. roadway. About $70,000. State will appropriate $35,000 toward cost. F. E. Johnson, c/o State Highway Dept., Lincoln, engr.

Neb., Minatare—Scotts Bluff Co. (Gering) having plans prepared and soon receives bids building rein.-con. arch bridge, here, to have twelve 50 ft. spans and 16 ft. roadway. About $70,000. State will appropriate $35,000 toward cost. F. E. Johnson, c/o State Highway Dept., Lincoln, engr.

Neb., Morrill—Scotts Bluff Co. (Gering) having plans prepared and soon receives bids building rein.-con. arch bridge here, to have twelve 50 ft. spans and 16 ft. roadway. About $70,000. State will appropriate $35,000 toward cost. F. E. Johnson, c/o State Highway Dept., Lincoln, engr.

Neb., Scottsbluff—Scotts Bluff Co. (Gering) having plans prepared and soon receives bids building rein.-con. arch bridge here, to have twelve 50 ft. spans, 24 ft. roadway and 4 ft. walks. About $100,000. Federal Government will appropriate toward cost. F. E. Johnson, c/o State Highway Dept., Lincoln, engr.

Tex., Rockwall—See "Streets and Roads."

Cal., Blythe—See "Railways" under California.

Cal., San Bernardino—City election soon to vote on $50,000 bonds to build bridge over Lytle Creek and $10,000 bonds for bridge over Warm Creek. W. L. Brown, city engr.

Cal., Vasalia—See "Streets and Roads."

Ont., Windsor—City and Dominion Government plan to build 2500 ft. suspension type bridge, 90 ft. wide, across Detroit River from Ouelette St., here, to Bates St., Detroit, Mich. J. A. Waddell & Son, 800 Graphic Arts Bldg., Kansas City, Mo., engrs

BIDS DESIRED

R. I., Barrington—Until Aug. 20, by State Bd. Pub. Rds., State House, Providence, building state bridges Nos. 72,106,108 and 122, known as Coventry Center Bridge, Coventry, Oak Valley and Branch River Bridge, Burrillville and Nyatt Bridge, here. Address A. L. Atwood, State Bd. Pub. Rds., Providence; advertised in this issue.

Pa., Harrisburg—Until Aug. 18, by Comrs. Dauphin Co., building 40 ft rein.-con. bridge over Paxton Creek on Shaonix St., 36 ff. wide; 30 ft. rein.-con. bridge over Paxton Creek on Sycamore St., 43 ft. wide; also 76 ft rein.-con. single span bridge over Flushing Creek, 18 ft. wide. C. M. Hershey, First Natl. Bank Bldg., engr.

Pa., Harrisburg—Until Sept. 23, by T. W. Templeton, supt. pub. grounds and bldgs., Commonwealth of Pennsylvania, constructing Soldiers' and Sailors' Memorial Bridge along Park Extension and State St. J. E. Greiner & Co., Fidelity Bldg., Baltimore, engrs. A. W. Brunner, 101 Park Ave., New York City, archt.; advertised in this issue.

Md., St. George Island—Until Aug. 19, by State Rds. Comn., 601 Garrett Bldg., Baltimore, building 984 ft. creosoted wooden pile and timber bridge, 14 ft. wide, 10 ft. clear roadway, over Potamac River from here to mainland. About $10,000. J. N. Mackall, state engr. Noted June 12; advertised in this issue.

S. C., Lockhart—Until Aug. 26, at office of Lockhart Mills, Lockhart, building steel highway bridge over Broad River, here; Advertised in this issue.

O., Toledo—See "Streets and Roads."

O., Toledo—Until Sept. 3, by D. H. Goodwille, serv. dir., building 40 ft., through bascule bridge, single leaf, 80 ft. wide, over Swan Creek, cost $65,000; also 80 ft. deck bascule bridge, single or double leaf, 80 ft. wide, on Summit St., $165,000. Bidder to submit own plans and specifications. H. C. McClure, city engr.

Michigan—Until Aug. 20, by State Highway Comr., Lansing building 200 ft. rein.-con. arch bridge, 24 ft. wide, over Thornapple Creek near Grand Rapids, consisting of one 70 ft. and two 65 ft. spans and 20 ft. roadway, involving 598 cu.yd. rein.-con. and 882 cu.yd. plain concrete. State Trunk Line Bridge No. 93, Kent Co.; 50 ft. span truss bridge over Sturgeon River near Sturgeon, two 10 ft. abutments and 20 ft. concrete flooring, 178 cu.yd. concrete, No. 291, Delta Co.; bridge over Prairie River near Bronson with two 35 ft. girders, 20 ft. roadway, two 8 ft abutments and one 8 ft. pier, 126 cu.yd. plain and 132 cu.yd. rein.-con., No. 205, Branch Co.; one 35 ft. girder bridge, 20 ft. wide, over Pine River near Standish, two 10 ft. abutments, 183 cu.yd. concrete, No. 257, Arenac Co.; bridge over Bird Creek, Port Austin, two 35 ft. girders and two 12 ft. abutments, 167 cu.yd. plain and 60.8 cu.yd. rein.-con., No. 315, Huron Co.; 40 ft. rein.-con. girder bridge over Hedge Creek at Crystal Falls, 20 ft. roadway, and two 8 ft. abutments, 85 cu.yd. plain and 94 cu.yd. rein.-con., No. 287, Iron Co.; bridge over Hog Creek at Quincy Twp., two 35 ft. rein.-con. girders, 20 ft. roadway, two 7 ft. abutments and one 7 ft. pier, 238 cu.yd. rein.-con., No. 203, Branch Co.

Minn., Duluth—Until Sept. 1, by Comrs. St. Louis Co., building 74 rein.-con. bridge in 6 districts. About $385,000. R. W. Acton, co. engr. Noted July 31.

Minn., Duluth—Until Sept. 9, by W. H. Bargen, treas. St. Louis Co., building 30 rein.-con. and steel bridges in 4th, 5th, 6th and 7th Dists., 18 ft. wide, lengths varying from 20 to 200 ft. About $200,000. R. W. Acton, co. engr.

Minn., Minneapolis — Until Sept. 2, by Comrs. Hennepin Co., building 840 ft. bridge, 20 ft. wide, on Cedar Ave. to have 5 spans and rein.-con. flooring, cost, $160,000; 800 ft. rein.-con. and steel bridge, 24 ft. wide, on Lyndale Ave., to have 100 ft. draw span, $170,000. E. E. Terrell, co. surv. Noted May 15 and July 24.

Minn., Pine City—Until Aug. 18, by A. P. Edin, aud. Pine Co., building Bridge No. 3128 between Sects. Nos. 28 and 29; No. 3125 between Sects. Nos. 25 and 26; No. 3128, 18 ft. rein.-con. slab span; No. 3126, 50 ft. rein.-con. deck girder span; No. 3125, 2 rein.-con. abutments, 36 ft. steel truss, hauled 9 mi. W. J. Buckley, Pine City, engr.

Ark., Marshall—See "Streets and Roads."

Wash., Underwood—Until Aug. 25, by State Highway Comn., Olympia, building 190 ft., steel bridge over White Salmon River, here. Skamania Co. About $10,000. J. Allen, state highway engr.

Ore., Albany—Until Aug. 20, by W. R. Bilyeu, judge Linn Co., building 4 rein.-con. bridges on Pacific Highway, Albany-Tangeut Sect., involving 30,000 lb. reinforcing steel, 450 cu.yd. Class "A" concrete, 324 lin.ft. concrete handrail, etc. About $10,000. D. H. Pierce, co. comr.

Ont., Orangeville—Until Aug. 19, by Wheelock & Christie, engrs., Orangeville, building one 4 ft., four 6 ft., one 8 ft., seven 10 ft., two 12 ft., one 14 ft., one 16 ft., one 20 ft., one 22 ft. and three 24 ft. rein. con. bridges and culverts for Dufferin Co. About $60,000.

Ont., Pickering—Until Aug. 19, by W. A. McLean, deputy minister highways, Toronto, building concrete abutments, concrete roadway and sidewalk floors, with other necessary work in connection with construction of bridge on Provincial Highway, and over Duffins Creek, here. About $65,000. G. Hogarth, Parliament Bldgs., Toronto, engr.

Ont., Port Hope—Until Aug. 19, by W. A. McLean, deputy minister highways, Toronto, building four 30 ft. concrete culverts, abutments, etc., on Provincial Highway from here to Coburg. About $60,000. G. Hogarth, Parliament Bldg., Toronto, engr.

PRICES AND CONTRACTS AWARDED
(★Indicates award of contract)

★**Maine**—State Highway Comn., Augusta, let contract building concrete arch bridge over Gilman Falls, 20 ft. wide, to have three 105 ft. spans and two 25 ft. spans to Cyr Bros., Waterville, $45,925. Work involves 1000 cu.yd. rein.-con., 800 cu.yd. concrete, 53 ton steel, 150 cu.yd. rock and 750 cu.yd. earth excav., etc. Noted Aug. 7.

Bridges (Continued)

Conn., East Lyme—State Highway Dept., Hartford, received lowest bid building concrete and steel drawbridge over Niantic River, from T. A. Scott Co., 292 Pequot Ave., New London, $48,081.

N. Y., Elmira—Bd. Pub. Wks. received bids July 7, building 830 ft. concrete bridge, 80 ft. high, consisting of 8 arches, over Chemung River on Main St., from Walsh Constr. Co., Herald Bldg., Syracuse, (a and b), $315,000, (Jan. 1, 1921); Concrete Steel Bridge Co., Clarksburg, W. Va., (b) $397,800, (July 31, 1921); T. L. Eyre, Commercial Trust Bldg., Phila., (a) $414,032, (b) $278,425, (Apr. 30, 1921); Amer. Bridge Co., 5 steel spans, new piers, $384,900, 5 steel spans, old piers, $356,430, 8 steel spans, 8 new piers, $367,530. Noted June 19.

★**N. J., Hackensack**—Bd. Supervs. Bergen and Hudson Counties let contract rebuilding steel work on Paterson Plank Rd. Bridge over Hackensack River, to Selbach-Meyer Co., 605 22nd St., West New York, $19,900. Noted July 31.

★**Fla., Jacksonville**—Duval Co. let contract furnishing material and building superstruction for steel bridge across St. John River here, to Bethlehem Bridge Corp., City Reality Bldg., Bethlehem, Pa., $534,180; foundations and approaches, to Missouri Valley Bridge & Iron Co., Pennsylvania Ave., Leavenworth, Kan., $374,447. Noted July 3.

★**Mont., Huntley**—State Highway Comn., Helena, let contract building 950 ft. bridge, 16 ft. wide, over Yellowstone River, near here, consisting of five 190 ft. spans, to Security Bridge Co., 502 North 32nd St., Billings, $163,341. Noted July 10.

Mont., Livingston—State Highway Comn., Helena, received bids building 270 ft. bridge, near here, Park Co., from B. M. Crenshaw, Glendive, $37,187; Nelson-Rich, $43,349; L. T. Lawler, Butte, $46,311. Work involves 1000 cu.yd. concrete and 90,000 lb. reinforced steel. Noted July 10.

★**Mont., Toston**—State Highway Comn., Helena, let contract building 529 ft. bridge, 16 ft. wide, over Missouri River near here, to Security Bridge Co., 502 North 32nd St., Billings, $55,334. Noted July 10.

Mont., Victor—Ravalli Co. received bid building 224 ft. bridge, 16 ft. wide, over Bitterroot River, near here, from Buell Bridge Co., Missoula, $17,719; Lord Constr. Co., Hamilton, $17,936. Noted July 17.

★**Ark., Marion**—Comrs. Rd. Impvt. Dist. No. 9 let contract building two 50 ft. steel girder spans and 308 lin.ft. concrete slab bridge, etc., near here, to Kansas City Bridge Co., 510 Orear-Leslie Bldg., Kansas City, Mo. Work involves 400 cu.yd. excav., $3.15 per cu.yd., 180 cu.yd. plain concrete, $25,625 cu.yd. rein.-con. $31.50, 100 lin.ft. steel girder spans, $54, etc., total cost, $38,205. Noted July 17.

Reinforced Concrete

PROPOSED WORK

Minn., Fergus Falls—See "Bridges."

BIDS DESIRED

O., Toledo—See "Streets and Roads."

Michigan—See "Bridges."

Minn., Duluth—See "Bridges."

Minn., Minneapolis—See "Bridges."

Ont., Orangeville—See "Bridges."

Ont., Pickering—See "Bridges."

Ont., Port Hope—See "Bridges."

PRICES AND CONTRACTS AWARDED

(★Indicates award of contract)

Cal., Los Angeles—See "Industrial Works."

Streets and Roads

PROPOSED WORK

Pa., Emsworth (Pittsburgh P. O.)—Boro plans to grade, pave and curb Locust St., vitr. brick pavement and stone curbing. About $15,000. P. H. Martin, 331 4th Ave., Pittsburgh, engr.

Pa., Pittsburgh—City passed ordinance to grade, curb and gutter Webster Ave. from Orion St. to Alpena Way. About $57,000. T. Reed, city engr.

Pa., Turtle Creek—Boro. election soon to vote $200,000 bonds to improve streets.

Pa., Turtle Creek—City rejected bids repaving Pennsylvania Ave. Work will be readvertised. Noted Aug. 7.

Pa., Turtle Creek—City having plans prepared by Harrop & Hopkins, archts., Home Trust Bldg., Pittsburgh, grading, paving and curbing 600 ft. Greensburg Ave., 30 ft. wide, involving 1800 sq.yd. vitr. brick on granite slag base and 1200 lin.ft. concrete curbing and guttering. Cost to exceed $10,000.

Md., Baltimore—See "Industrial Works."

W. Va., Huntington—Comrs. Cabell Co. rejected bids paving 1 mi. Huntington-Hamlin Rd., 16 ft. wide, involving 9300 sq.yd. vitr. brick on 4 in. cement concrete base. About $35,000. Oliver & Maupin, Huntintgon, engrs. Noted July 24.

W. Va., Morgantown — Monongalia Co., Union Dist., election Sept. 6, to vote on $150,000 bonds to build roads. L. M. Cox, co. engr.

Fla., Jacksonville—City voted $200,000 bonds to improve and build streets. F. N. Edwards, city engr.

Ohio—State Highway Comn., Columbus, rejected bids received Aug. 5, grading, building bridges and culverts and paving 5.49 mi. Sect. G, St. Mary's Celina Rd., plain concrete, Mercer Co.; 3.52 mi. Sect. F, Sidley-Wapakoneta Rd., plain concrete or bituminous macadam, Shelby Co.; 4.0009 mi. Sect. A, 3.831 mi. Sect. B, 3.579 mi. Sect. C, 2.653 mi. Sect. D, and 2.617 mi. Sect. E, Akron-Cleveland Rd., rein.-con., Summit Co. Noted July 24.

O., Springfield—City plans to repave Fountain Square, involving 2500 sqyd. vitr. brick on concrete base. About $11,500. O. E. Carr, City mgr.

Michigan—F. F. Rogers, State Highway Comr., Lansing, soon lets contract furnishing labor and material for grading, shaping, draining, gravel surfacing, etc., 3.289 mi. State Trunk Line Rd. No. 24-1, 16 ft. wide, Austin and Colfax Twps., Mecosta Co.; 3.780 mi. State Trunk Line Rd. No. 12-1, 16 ft. wide, St. Ignace Twp., Mackinaw Co.; 7.083 mi. State Trunk Line Rd. No. 25-3, 16 ft. wide, Lakefield Twp., Luce Co., all gravel; 1.236 mi. State Trunk Line Rd. No. 11-3, 16 ft. wide, Olive Twp., Ottawa Co.; 2.155 mi. State Trunk Line Rd. No. 50-1, Ridgeway Twp., Lenawee Co., both bituminous concrete or concrete surface.

Michigan—State Highway Dept., Lansing, plans to grade, drain and surface with concrete or bituminous concrete, 1.236 mi. Trunk Line Rd., No. 11-3, 16 ft. wide, Ottawa Co., involving 6421 cu.yd. excav., 11,602 sq.yd. bituminous concrete or 2363 cu.yd. concrete.

Mich., Detroit—City soon lets contract paving Fenkell Ave. from 12th to Livernois Sts., 26 ft. wide, sheet asphalt; Colfax Ave. from Warren to Milford Sts., Clements Ave. from Herman to 12th Sts., Florida Ave. from Michigan to Radcliffe Sts., Fullerton Ave. from Oakman Blvd. to Wabash Ave., Northfield Ave. from Warren to Tireman Sts., Otsego Ave. from Joy to Graham Sts., Olivet St. from Distel to Woodmere Sts., Pingree Ave. from Linwood St. to Dexter Blvd., Schroeder Ave. from West Jefferson to South Sts., Sylvan St. from McKinley to Vincent Sts., Wilson Ave. from Hazelwood to Taylor Sts., 24-26 ft. wide, asphaltic concrete on 6 in. concrete foundation, berea, medina or amherst curbstone. Work involves 42,378 cu.yd. excav., 46,277 lin.ft. curbstone and 71,132 sq.yd. paving, etc. C. W. Hubbell, city engr.

Ill., Chicago—Bd. Local Impvts. rejected bids received July 23, paving North State St. from Madison to Randolph Sts., and from Randolph to South Water Sts. C. D. Hill, ch. engr. Noted Aug. 7.

Wis., Sheboygan—City plans to grade and pave 1.3 mi. Georgia Ave., from 6th to 17th Sts. and city limits, 18 ft. and 20 ft. wide, involving 7500 sq.yd. concrete and 2900 lin.ft. concrete curb and gutter. Cost between $17,000 and $20,000. C. U. Boley, city engr.

Minn., Duluth—J. A. Farrell, city comr., soon lets contract improving 3262 ft. 22nd Ave., W., from Superior to 7th Sts., 24 ft. wide, involving 3708 sq.yd. vitr. brick, 4790 sq.yd. concrete, 4967 lin.ft. concrete curbing, 13,080 sq.ft. retaining wall and 1643 ft. 12-18 in. sewer pipe. About $57,043. E. K. Cae, city engineer's office, engr.

Minn., Little Falls—Comrs. Morrison Co. rejected bids received Aug. 5, grading and graveling 24 mi. Federal Aid Project No. 24, 18 ft. wide. About $120,000. Work may be readvertised. Noted July 24.

Kan., Minneapolis—Comrs. Ottawa Co. plan to hard surface 25 mi. Meridian Rd., from Cloud Co. line to Minneapolis, to Bennington and to Saline Co. line. J. H. Boyle, co. engr.

Montana—State Highway Comn., Helena, rejected bids received July 25, gravel surfacing 18 mi. Sun River Rd., Cascade Co., and 3 mi. Billings-Cody Way, Carbon Co., Federal Aid Project No. 4. P. B. Pratt, state highway engr. Noted July 24.

Mo., Bethany—Harrison Co. rejected bids received July 23, grading, paving with concrete, laying macadam shoulders, etc., on 9.4 mi. State Rd. No. 8, 9 ft. wide. M. G. Hall, Centerville, Ia., engr. Noted July 10.

Mo., Carthage—Jasper Co. election Sept. 19, to vote $700,000 bonds to build hard surface roads.

Mo., Clinton—Henry Co. election Sept. 9, to vote on $150,000 bonds to build hard surface roads.

Mo., Grant City—Worth Co. election soon to vote $500,000 bonds to build hard surface roads.

Mo., Houston—Texas Co. voted $225,000 bonds to build Ozark Highway. C. L. Johnson, presiding judge.

Mo., Poplar Bluff—Comrs. Butler Co. soon receives bids building 50 mi. St. Louis-Poplar Bluff Rd. and Jefferson City-Poplar Rd., through Arcadia Valley, concrete. About $1,100,000. E. C. Nickey, Poplar Bluff, co. highway engr.

Mo., Shelbyville—Shelby Co. election soon to vote $1,000,000 bonds to build hard surface roads.

Mo., Springfield—Green Co. election Sept. 15, to vote $2,000,000 bonds to build hard surface roads.

Tex., Corpus Christi—Comrs. Neuces Co. voted $2,000,000 bonds to build roads. Engineer not selected. Noted July 3.

Tex., Eastland—Eastland Co., plans election to vote on $3,000,000 bonds to improve 100 mi. highway.

Tex., Falfurrias—Brooks Co. soon lets contract excavating, grading, sub-grading, caliche surfacing, excavating and building concrete drainage structures on 10.75 mi. State Highway No. 12 from Encino to south line Brooks Co., 16 ft. wide. Work involves 10.358 mi. machine grading, 14,025 cu.yd. unclassified earth excav., 1293 lb. reinforced steel, etc. About $37,701. H. S. Bedell, Falfurrias, engr.

Tex., Granbury—Hood Co. soon lets contract building 6 mi. waterbound macadam road with bituminous surface and concrete drainage structures on State Highway No. 10 from Erath Co. line to Tolar, 16 ft. wide. About $85,000. G. Tarrant, co. judge. Burks, Firmin & Hart, Granbury, engrs. Noted June 19.

Tex., Oakville—Live Oak Co. voted $60,000 bonds to build lateral roads and State Highways Nos. 9 and 12B. Engineer not selected. T. H. Miller, co. judge.

Tex., Rockwall—Rockwall Co. plans to build 13.36 mi. Highway No. 1 from Dallas Co. line to Collin Co. line, 18 ft. wide, 1 course plain and 1 course rein.-con. pavement, involving rein.-con. drainage structures, concrete trestle, 1200 ft. bridge across levee of Trinity River, 140,000 sq.yd. concrete pavement and 410,000 lb. steel. About $544,816. J. Montgomery, Rockwall, engr.

Okla., Ada—City having plans prepared paving 50 blocks. About $500,000. Johnson & Benham, Firestone Bldg., Kansas City, Mo., engrs.

Okla., Stroud—City having plans prepared paving 5 blocks. About $40,000. Johnson & Benham, Firestone Bldg., Kansas City, Mo., engrs.

Idaho, Fairfield—Town soon lets contract building and furnishing 20,650 lin.ft. 4 in. sidewalks, and 5960 lin.ft. 6 in. crossings. S. Stinton, clk.

Idaho, Malad—Oneida Co. voted $250,000 bonds to improve highways. J. H. Giles, Pocatello, engr.

Idaho, Payette—Payette Co. voted $200,000 bonds to build roads. J. Smith, co. clk.

Idaho, Rupert—City plans to pave, curb and gutter various streets. About $118,500.

Idaho, Sandpoint—Bonner Co. plans to grade and drain 7 mi. Bottle Bay Rd. About $20,000. C. W. Wilson, Sand Point, engr.

Idaho, Soda Springs—Town Council soon lets contract building 80,096 sq.ft. 4 in. sidewalks, 11,200 sq.ft. 6 in. crossings and 1500 cu.yd. excav. A. Meyers, clk.

Utah—State Highway Comn. Salt Lake City, soon lets contract paving 2.1 mi. state road from Ray to present city limits, and 4 mi. from North Ogden to Utah Hot Springs, involving (a) 6-8 in. monolithic concrete, (b) 2 in. bitulithic top on 6 in.